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TABLE OF CONTENTS

No. 1. January–February

No. 2. March–April

No. 3. May–June

No. 6. NOVEMBER–DECEMBER

MYCOLOGIA

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NEW AND UNUSUAL AGARICS FROM NORTH AMERICA. II[1]

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(WITH 2 FIGURES)

Six new species are described and one new combination is made in the following account. In all, ten species distributed in *Hypholoma, Inocybe* and *Tricholoma* are considered. The specimens were collected in the Great Smoky Mountains National Park in Tennessee and North Carolina, the Adirondack Mountains of New York, Michigan, and the Pacific Coast Region.

As limited here, the genus *Hypholoma* includes those species placed in the genus *Nematoloma* by some European authors. The limits of *Hypholoma* are thus extended to include a series of mostly bog-inhabiting species of gregarious habit and slender stature formerly placed in *Psilocybe,* which have long been known to differ from the lignicolous more or less caespitose species of *Hypholoma* only in size, habit and habitat. When so limited, the genus *Hypholoma* comprises a group of very closely related species. The character of fleshy or cartilaginous stem is scarcely a usable specific distinction in this group and utterly without value as a possible generic distinction. Viscidity of the stipe, like that of the pileus, appears to be a specific character, and, at least for the present, seems to be without particular phylogenetic significance in this group. Of the two species with viscid stipes admitted here, one is obviously very closely related to *Hypholoma udum.* The other

[1] Papers from the University of Michigan Herbarium.

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does not appear to be closely related to any other species of agaric and is placed in *Hypholoma* because of the cystidia and the truncate apices of its spores.

The curious pleurocystidia (which can be demonstrated best in dried material which has been revived in KOH) are a very reliable generic character. The cystidia and the structure of the pileus are correlated with a certain aspect which the collector soon learns to recognize in the field, and by which the group, with the exception of *H. anomalum*, can be readily identified at sight.

The fragile species with a layer of inflated cells forming the cuticle of the pileus are of course excluded. These are now placed in the genus *Psathyrella* along with most species formerly referred to *Psathyra* and some previously placed in *Psilocybe*.

The collection numbers cited are the writer's. All color names within quotation marks are taken from R. Ridgway, Color Standards & Color Nomenclature, Wash. D. C. 1912. The specimens are all deposited in the Herbarium of the University of Michigan.

Hypholoma anomalum sp. nov. (FIG. 2 *B, C, E*)

Pileus 2 cm. latus, conico-umbonatus, glutinus, subrimosus, laete ochraceus; lamellae angustae, adnatae, subdistantes, olivaceo-luteae; stipes 4.5 cm. longus, 2.5 mm. crassus, equaliter, glutinosus, apice siccus, fibrillose pruinosus, sursum pallide luteus, deorsum aurantioluteus; sporae 11–14 × 5.5–7 μ; pleurocystidia et cheilocystidia 35–50 × 6–12 μ, lutea, submucronata. Specimen typicum legit prope Grassy Patch, Great Smoky Mountains National Park, Tenn., Sept. 3, 1938, A. H. Smith n. *10782*, in Herb. Univ. of Mich. conservatum.

Pileus 2 cm. broad, plane with an abrupt conic umbo and slightly decurved margin, surface glutinous, subrimose along the margin beneath the gluten, appearing finely appressed fibrillose under a lens, disc "raw sienna," the remainder "ochre yellow" (bright yellow), when dried the disc "tawny" and the margin "amber brown" (bright yellowish brown); flesh pale yellow, firm, odor and taste not distinctive; lamellae narrow, depressed-adnate, subdistant, equal, near "Isabella color," edges even; stipe 4.5 cm. long, 2.5 mm. thick, equal, glutinous over the lower two-thirds and orange yellow, pale yellow and fibrillose scurfy above, soon dry and appearing agglutinated fibrillose under a lens; spores 11–14 × 5.5–7 μ, rusty brown in deposit and pale cinnamon brown under the microscope, furnished with an apical hyaline pore and an inconspicuous hyaline apiculus, smooth in KOH (in water-mounts of

fresh material the exospore appeared slightly wrinkled); basidia four-spored; pleurocystidia and cheilocystidia abundant, sessile or with a thick short often curved pedicel, mucronate to subfusoid (similar in shape to those of *Hypholoma udum*), 35–50 × 6–12 μ, imbedded or projecting, yellow in water mounts of fresh material, hyaline or rusty brown in KOH, usually with a highly refractive amorphous content, scattered cheilocystidia of the thin-walled saccate to fusoid type also present; gill-trama with contorted highly refractive lactifers; pileus-trama made up of a surface layer of innate hyphae 4–5 μ thick with their free portions gelatinous (not forming a typical separable pellicle), the hyphae arising from a compact highly colored but otherwise not differentiated hypodermis, the remainder faintly yellowish and homogeneous, lactifers present.

Singly under rhododendron, Grassy Patch, Great Smoky Mts. National Park, Tenn., Sept. 3, 1938, No. *10782*.

This most interesting and unusual agaric is known from a single specimen, but in view of its striking microscopic characters it would be difficult to mistake it for any other known agaric. The combination of cystidia and spores relate it to the slender species of *Hypholoma* included in this paper, and it is on this basis that I place it here. However, the color of the fresh spore deposit offers no suggestion of such a relationship. This may seem to be a serious discrepancy at first, but it should be remembered that *Hypholoma elongatipes* was described previously both as a *Naucoria* and a *Psilocybe* because of its brown spore color, or at the most only slightly reddish-tinged spores. The combination of the glutinous stipe and pileus of *H. anomalum* are also unusual in *Hypholoma,* but do not exclude it from that genus. The fungus reminded me of an *Inocybe* when it was collected. However, the viscid stipe, truncate spores, *Hypholoma*-like cystidia and viscid cap make a combination of characters not found in species of *Inocybe.* It is equally out of place in any of the genera Singer (8) has placed in the Cortinariaceae.

Hypholoma viscidipes sp. nov.

Pileus 1–2 cm. latus, obtuse campanulatus, glaber, viscidus, hygrophanus, pallide brunneus demum subisabellinus; lamellae adnatae, latae, confertae, pallidae, demum obscurae; stipes 7–10 cm. longus, 2–2.5 mm. crassus, cavus, cartilaginus, viscidus, apice subfrillosus; sporae 9–12 (14) × 6–7 μ. Speci-

men typicum legit prope Mud Lake Bog, Whitmore Lake, Mich., Oct. 5, 1939, A. H. Smith n. *14945,* in Herb. Univ. of Mich. conservatum.

Pileus 1–2 cm. broad, broadly conic, becoming campanulate, surface glabrous, viscid, opaque, margin incurved at first, color "cinnamon brown" to "Sayal brown" when moist, fading to "clay color" or "cinnamon buff" (dark to pale rusty brown and fading to pale buff or sordid yellowish brown, pale tan in dried specimens); flesh soft, rather thick, pallid watery brown, fading to buff, odor and taste not distinctive; lamellae bluntly adnate, developing a decurrent tooth, close to crowded (27–32 reach the stipe), 3–4 mm. broad (quite broad), pale grayish when young, slowly becoming dull chocolate brown, edges white-fimbriate; stipe 7–10 cm. long, 2–2.5 mm. thick, equal, hollow, pliant, glutinous from a thin gelatinous layer (readily demonstrable under the microscope in mounts of fresh material), glabrous or appearing somewhat appressed fibrillose beneath the gluten, arising from deep in the moss beds but no typical pseudorhiza evident; spores ellipsoid, 9–12 (14) $\times$ 6–7 μ, purple brown in mass, sordid yellowish brown under the microscope when revived in KOH, smooth; basidia four-spored; pleurocystidia scattered, mucronate to clavate, content appearing granular in fresh material but when revived in KOH appearing as an irregular amorphous mass which is highly refractive; cheilocystidia very abundant, narrowly clavate to subcapitate, thin-walled, hyaline; pileus-trama homogeneous beneath a gelatinous separable pellicle made up of hyphae about 2 μ in diameter, the hyphae of the tramal body 8–9 μ thick.

Scattered on moss in an old burn, Mud Lake Bog, Whitmore Lake, Mich., Oct. 5, 1939, *14945*-type.

This fungus is most closely related to *Hypholoma udum,* but can be distinguished at once by the viscid stipe. In addition the spores are distinctly smaller. There is no appreciable difference in color between the two. In a superficial way, *H. viscidipes* resembles the viscid-stiped species of *Stropharia* centering around *S. semigloboides* Murr. However, its partial veil is represented by only a few appressed fibrils beneath the gluten of the stipe and no annulus or distinct fibrillose fringe is present on it. It must be recognized that the slender species of *Hypholoma* are very closely related to the slender viscid-stiped species of *Stropharia.* The discovery of *H. viscidipes* makes this similarity even more striking. Singer (7) apparently does not admit species with viscid stipes in *Nematoloma.* This brings up the question concerning the disposition of the two

fungi described here. *H. anomalum* and *H. viscidipes* might be placed in a genus by themselves. *H. anomalum,* however, bears no resemblance to *H. udum* whereas *H. viscidipes* could easily be mistaken for it, if the viscidity of the stipe and the spore size were not carefully checked. *H. anomalum,* in fact, has no obvious relationship with any other species of *Hypholoma.* It might be just as logical to place it in *Stropharia,* where it would most certainly be effectively buried because of its complete lack of an annulus.

Hypholoma elongatipes (Peck) comb. nov. (*Agaricus elongatipes* Peck, Ann. Rep. N. Y. State Mus. **29**: 40. 1878. *Naucoria obtusissima* Kauff. Papers Mich. Acad. **17**: 188. 1933).

This is a rather confusing species because of its brown spores. The color of the spores led Kauffman to place it in *Naucoria* where it was described as a new species in 1933. Both Kauffman and I overlooked the characteristic cystidia. Up to the time of our publication, we had studied the fungus only in the fresh condition. The pleurocystidia are imbedded in the hymenium, and are hyaline when fresh. Consequently, they are easily overlooked. In mounts of the gills revived in KOH, the amorphous highly refractive content enables the cystidia to be located readily. I have studied Peck's type and found that the Michigan specimens are identical with it. The spores of the type measure 9–11 × 5.5–6 μ. In material collected at Lake Timagami, Ont., during the season of 1936, the spores measured 9–12 × 5–6 μ whereas in most Michigan collections they are 8–11 × 5–6 μ.

A species very similar to *H. elongatipes* is found in Denmark. Lange (**5**) reports it under the name *Psilocybe elongata,* but refers both *Psilocybe uda* subspecies *elongata* and *P. uda* subsp. *Polytrichi* in the sense of Fries to it. Kühner (**3**) has given an account of *Hypholoma Polytrichi* sensu Ricken which is at variance with Lange's conception of *P. elongata.* Since I have found a species in North America which appears to be *H. Polytrichi* sensu of Ricken, I am using that name for it in the absence of a better one.

HYPHOLOMA POLYTRICHI Fries sensu Ricken.

Pileus 10–25 mm. broad, obtusely conic becoming campanulate and finally expanded, with or without a low umbo, glabrous except for scattered superficial fibrils along the margin at first, subviscid to moist, subhygrophanous, " clay color," " tawny olive " or " Isabella color " at first (sordid pale tawny or olivaceous brown), fading to near " chamois " (pale yellowish buff), opaque when moist or only the extreme margin translucent striate; flesh yellowish, cartilaginous, odor and taste not distinctive; lamellae close, narrow (2–3 mm.), bluntly adnate, " olive ocher " to " olive yellow " (greenish yellow) at first, becoming dark sordid purplish brown; stipe 5–7 cm. long, 1.5–2.5 mm. thick, equal, rigid and very cartilaginous, smooth or twisted, glabrous or with faint patches of appressed fibrils below, pruinose above, tawny brown toward the base and becoming sordid over the lower portion in age, apex near " olive ochre " (pale greenish yellow); spores $7–9 \times 3.5–4$ (4.5) μ, ellipsoid, smooth, with an apical hyaline pore, purple brown under the microscope in water mounts of fresh material, sordid pale bister when revived in KOH; basidia four-spored; pleurocystidia abundant, $40–60 \times 10–12$ (15) μ, mucronate, with an amorphous content when revived in KOH; cheilocystidia $28–36 \times 7–10$ μ, fusoid ventricose, hyaline, content not distinctive; pileus-trama with a slightly differentiated hypodermis beneath a very thin subgelatinous pellicle.

Gregarious on sphagnum and other mosses near Lake Michigamie, Michigamie, Mich., Sept. 11, 1933 (33–943).

The specimens described above do not agree in all their characters with the European fungus as it is described by Ricken (**6**) and Kühner (**3**). The important character, however, is the spore size. Both of the above authors characterize *H. Polytrichi* as a small spored species. I have but one collection of it, and in that one the spores are distinctly smaller than in the very common *H. squalidellum.*

HYPHOLOMA SQUALIDELLUM (Peck) Sacc.

Pileus 1–3 (4) cm. broad, conic to convex, becoming campanulate, expanded and with an obtuse umbo or plane to broadly convex in age, the margin frequently recurved in umbonate forms, surface glabrous and moist, either opaque or the margin faintly striatulate, the margin occasionally decorated with scattered fibrils from the remains of the rudimentary veil, color variable, bright or sordid

rusty brown when moist, subhygrophanous and fading to yellowish buff ("zinc orange," "cinnamon rufus," "Saccardo's umber," "clay color" or near "cinnamon brown" at first and fading to "ochraceous buff," "honey yellow" or "deep colonial buff"); flesh thin but firm, somewhat cartilaginous, yellowish in age, pallid when young, odor and taste not distinctive; lamellae close, narrow or becoming broad only in extreme age, adnate, sometimes developing a slight tooth, whitish at first or pale olivaceous gray, sometimes "pale greenish yellow," at times developing a strong olive tinge before becoming purple brown; edges even; stipe variable in length depending on the habitat, when on naked peat soil 3–5 cm. long, when growing in sphagnum 6–10 cm. long, 1.5–3 mm. thick, equal, usually flexuous when growing in the open, very brittle and cartilaginous, covered at first with scattered patches of appressed fibrils which are the remains of a rudimentary partial veil, apex pruinose, pallid brownish toward the base when young, in age becoming rusty brown and finally "bister" (sordid blackish brown), paler and olivaceous to pale yellowish above; spores (8) 9–11 (12) $\times$ (4) 5–6 μ, ellipsoid, smooth, with an apical hyaline pore, bright purplish brown under the microscope when fresh, sordid yellowish brown or pale bister when revived in KOH; basidia four-spored; pleurocystidia numerous, 28–40 $\times$ (8) 9–12 μ, ventricose and mucronate, with a highly refractive amorphous content when revived in KOH, scarcely projecting beyond the basidia; cheilocystidia abundant, hyaline, fusoid ventricose to clavate, 28–35 $\times$ 6–9 μ; pileus-trama with a poorly formed subgelatinous pellicle and a differentiated hypodermis of slightly enlarged cells, both the tramal body and hypodermis dull yellowish brown in KOH.

Usually densely gregarious on peat in bogs, but also along the edges of marshes and on poorly drained areas. According to my experience it is as common as *Hypoloma udum* and very frequently occurs in great quantity during dry years when other agarics fruit only sparingly. I have collected it in the Cape Flattery Region of Washington, in Michigan, Ontario, and in the Adirondack Mountains of New York. As in *Hypoloma udum,* the colors are variable. In some collections the young gills are grayish or whitish and the apex of the stipe is pallid, in others both parts may show distinct olivaceous or yellowish hues.

I have examined the type of *Psilocybe squalidella* var. *macrosperma* and found it to be the same as *Hypholoma udum. Psilocybe squalidella* var. *caespitosa* is a cespitose form of the species, but does not differ in any essential character. I have collected this

form in Ontario on debris in a dry creek bed and believe the habit is caused by the nature of the substratum and that it will vary accordingly.

In the type of the species the spores measure 9–11 × 5–6 μ. In most of my collections 8–10 (11) × 5–6 μ was the typical range. *Hypholoma udum* and *H. squalidellum* are practically indistinguishable macroscopically, but can be readily separated by the sharp difference in spore size. It is apparent from the European literature that the series of forms centering around *Hypholoma udum* is very confusing. Because of this, it seems best at present to adhere to the American names which, fortunately, are based on well preserved types.

HYPHOLOMA UDUM (Fries) Quél. (FIG.) (*Psilocybe squalidella* var. *macrosperma* Peck, N. Y. State Mus. Bull. **157**: 98. 1912.

Pileus 1–3 (5) cm. broad, obtusely conic to convex when young, the margin usually slightly incurved, becoming broadly convex or plane, sometimes slightly umbonate, surface moist, lubricous when wet, at first with scattered superficial fibrils along the margin from the almost rudimentary partial veil, soon glabrescent, often entirely glabrous from the beginning, somewhat hygrophanous, color extremely variable, when young pale or dark rusty brown, becoming yellowish brown and finally fading to pale yellow or buff, watersoaked specimens frequently dark purplish brown tinged with olive (" ferruginous," " orange cinnamon," " tawny " or " sudan brown " when fresh and moist, fading to " baryta yellow," " light orange yellow " or " pale ochraceous salmon " and in age finally becoming " Isabella color ") ; flesh thick under the disc, pliant, yellowish, odor none or not distinctive, taste slightly bitterish; lamellae bluntly adnate, close to subdistant, broad, whitish to " cream buff " or " chamois " (pale yellowish) at first, soon sordid purplish brown from the spores but olive-yellow tints frequently persisting, edges whitish; stipe 4–12 cm. long, 1.5–4 mm. thick, equal, cartilaginous, tubular, " ferruginous " to " russet " (dark rusty brown) below, pale yellowish above or occasionally whitish, surface with scattered patches of appressed fibrils from the remains of the poorly developed partial veil, glabrescent; spores 14–18 (20) × 5–7 μ, with a very small apical germ pore (use oil immersion lens), smooth, ellipsoid or the midportion slightly ventricose, bright purplish brown under the microscope when fresh, sordid brown when revived in KOH; basidia four-spored; pleuro-

cystidia 30–50 × 8–12 μ, broadly fusoid to mucronate, with a highly refractive content when revived in KOH; cheilocystidia 25–37 × 7–10 μ, filamentose, fusoid ventricose or subcapitate, thin walled, hyaline, usually forming a broad sterile band on the gill-edge; pileus-trama characterized by a poorly organized pellicle, a well developed hypodermis of enlarged cells and a filamentose tramal body.

Although not frequently reported, according to my experience it is the commonest bog-inhabiting agaric in northeastern United States. Kauffman's (2) account of it undoubtedly applies to a species of *Stropharia,* and Peck apparently confused subhygrophanous forms of it with *Psilocybe squalidella* creating two varieties, var. *macrosperma* and var. *deformata.* Mr. Seth Lendell of Upsala, Sweden, has kindly verified my determination of *H. udum* and sent me specimens collected in Sweden. It is a most variable fungus in many respects. The colors of the pileus are a mixture of yellow, brown and green, the green usually becoming more conspicuous in age. Sometimes it appears hygrophanous and sometimes not, depending on the weather conditions. The gill colors vary considerably from olive gray to pale yellowish. Although I have observed the fungus for ten years in a local bog, I have never been able to correlate the olive gray and yellow gills with any other characters, and in fact quite frequently find merely an intergrading series of individuals. All of the collections admitted here are characterized by the large spores on four-spored basidia. Two-spored basidia have been observed, but the exceptionally large spores have not been demonstrated on them. However, I suspect that that is where they are produced.

Inocybe cinnamomea sp. nov. (FIG. 1 *A, B, C*)

Pileus 10–25 mm. latus, obtuse conicus demum subcampanulatus, siccus, fibrillosus, subcinnamoneus; lamellae adnatae, confertae, latae, cinnamomeae demum incarnatofulvae; stipes 4–6 (8) cm. longus, 4–6 mm. crassus, equaliter vel subclavatus, solidus, fibrillosus, cinnamomeus; sporae 7–9 × 4–5.5 μ; cheilocystidia et pleurocystidia 40–60 × 10–20 μ. Specimen typicum legit prope Crescent City, Calif., Nov. 4, 1937, A. H. Smith, n. *8440,* in Herb. Univ. of Mich. conservatum.

Pileus 10–25 mm. broad, obtusely conic, remaining unexpanded or becoming merely broadly conic to broadly campanulate in age, surface dry and densely appressed fibrillose, toward the margin

FIG. 1. *A–C, Inocybe cinnamomea; D–F, I. insignis; G, I. luteifolia.*

the fibrils become arranged in fascicles but not into true scales, not rimose and not becoming rimose in drying, disc near "wood brown" to "verona brown," "Sayal brown" to "cinnamon" toward the margin (dark avellaneous to dull reddish brown on the disc and the margin pale cinnamon colored), unicolorous and dark avellaneous when dry; flesh soft, fragile, watery, pallid

cinnamon, odor none, taste distinctly disagreeable; lamellae ascending adnate, moderately close, fairly broad, variable in color, "cinnamon" or tinged salmon color at first, "ochraceous tawny" at maturity or with a pronounced salmon tinge evident, not changing color when bruised; stipe 4–6 (8) cm. long, 4–6 mm. thick, equal or slightly clavate below, solid, covered evenly by a soft coating of "cinnamon" fibrils which in age tend to become arranged in patches, flesh within pale cinnamon, glabrescent in age or where handled; spores subovoid, smooth, dull tawny under the microscope, 7–9 × 4–5.5 μ; basidia four-spored; cheilocystidia of two types, the first type saccate to subclavate, thin-walled and hyaline, the second 25–33 × 10–20 μ, fusoid ventricose, the apices slightly incrusted and the walls above the inflated portion only slightly thickened.

Scattered under second growth spruce, Crescent City, Calif., Oct. 30, 1937 (*8226*), and Nov. 4 (*8440*-type). Occasional specimens have been encountered in other localities in northern California and southern Oregon. It was abundant only in the type locality about five miles north of Crescent City.

I. cinnamomea is most closely related to *Inocybe pallidobrunnea* Kauff. but can be readily distinguished by its bright cinnamon gills which tend to become flushed with salmon color. In addition, the spores of Kauffman's species are slightly larger and its cystidia are longer and less ventricose. The fibrils of the stipe of *I. cinnamomea* should also aid in distinguishing the two. In Heim's account of the genus (1) it would fall in the section Fibrillosae near *I. eutheles* from which it is also readily distinguished by its dominant cinnamon color.

Inocybe insignis sp. nov. (FIG. 1 *D, E, F*)

Pileus 5 cm. latus, acute conicus, demum conicocampanulatus, fibrillosus, demum valde rimosus et fibrillose squamosus, sordide luteobrunneus, tactu virescens; odor valde aromaticus; lamellae adnatae, conferatae, angustae, sordide fulvae, tactu virescens; stipes 6 cm. longus, 4 mm. crassus, equaliter vel subbulbosus, sordide luteobrunneus, dense pruinosus vel subpubescens, tactu virescens; sporae (8) 9–12 × (6) 7–10 μ, valde nodulosa; cheilocystidia et pleurocystidia subfusoidea vel subglobosa, 40–65 × 12–25 (30) μ. Specimen typicum legit prope Keener House, Great Smoky Mts. National Park, Tenn., Aug. 3, 1938, A. H. Smith, n. *9781*, in Herb. Univ. of Mich. conservatum.

Pileus 5 cm. broad, sharply conic, becoming broadly campanulate, surface dry, appressed fibrillose, becoming lacerate scaly and

conspicuously rimose, " sepia " on the disc, near " Saccardo's umber " toward the margin, when dry " warm sepia " over all, turning greenish where bruised; flesh thin, moderately soft, pallid brownish, sordid green after being cut or bruised, taste slightly bitterish, odor pronounced, heavy but somewhat aromatic; lamellae close, narrow, adnate, sordid cinnamon brown, staining greenish where cut or bruised; stipe 6 cm. long, 4 mm. thick, equal above a somewhat bulbous base, concolorous with the pileus or paler brown above, densely pruinose or almost finely pubescent over all, staining sordid greenish gray where handled; spores (8) 9–12 × (6) 7–10 μ, dark brown under the microscope, very irregular in shape, with 9–13 very pronounced nodules; basidia four-spored; cheilocystidia and pleurocystidia similar, subcylindric to subfusoid or occasionally nearly globose, apices usually encrusted, the walls usually conspicuously thickened, hyaline or faintly yellowish in KOH, 40–65 × 12–25 (30) μ.

Singly under mixed beech and hemlock near Keener House, Great Smoky Mountains National Park, Tenn., Aug. 3, 1938, *9781*-type.

The species is known only from the type. It possesses so many unusual characters that it would be difficult to confuse it with any other *Inocybe*. In Heim's classification (1) it appears to be closest to *I. capucina* but is readily distinguished by the more nodulose spores, the change to greenish exhibited by all bruised portions, and apparently by a different odor. There is in addition a difference in the cystidia, but in view of the variation found on a single pileus, this should be regarded as of secondary importance. In its spore characters it approaches *Inocybe nodulosa* Kauff. or *Inocybe intricata* Peck, but is readily distinguished from both by its heavy odor as well as by the changing flesh.

Inocybe luteifolia sp. nov. (FIG. 1 *G*; 2 *A, D*)

Pileus 1–3 cm. latus, obtuse conicus demum planoumbonatus, siccus, fibrillosus demum subsquamosus, sordide brunneus demum subfulvus, margine subluteus; sapore subrancidus; lamellae angustae, confertae, adnatae, luteae, tactu luteobrunneae; stipes 3–5 cm. longus, 3–5 mm. crassus, solidus, equaliter, dense pruinosus, demum glaber, pallidus vel pallide luteus, deorsum demum atrobrunneus; sporae 6–8 × 4–5 μ; pleurocystidia et cheilocystidia 35–45 (50) × 10–15 μ, lutea. Specimen typicum legit prope Oak Hill Road, Oakland Co., Mich., July 17, 1937, A. H. Smith, n. *6557*, in Herb. Univ. of Mich. conservatum.

Pileus 10–30 mm. broad, obtusely conic when young, becoming plane except for a low obtuse umbo, at times the umbo obsolete, surface dry, innately appressed fibrillose at first and appearing "sepia" (dark sordid yellowish brown) because of the even fibrillose coating, in age the fibrillose layer breaking up into appressed scales, ground color yellowish, the disc becoming tinged reddish

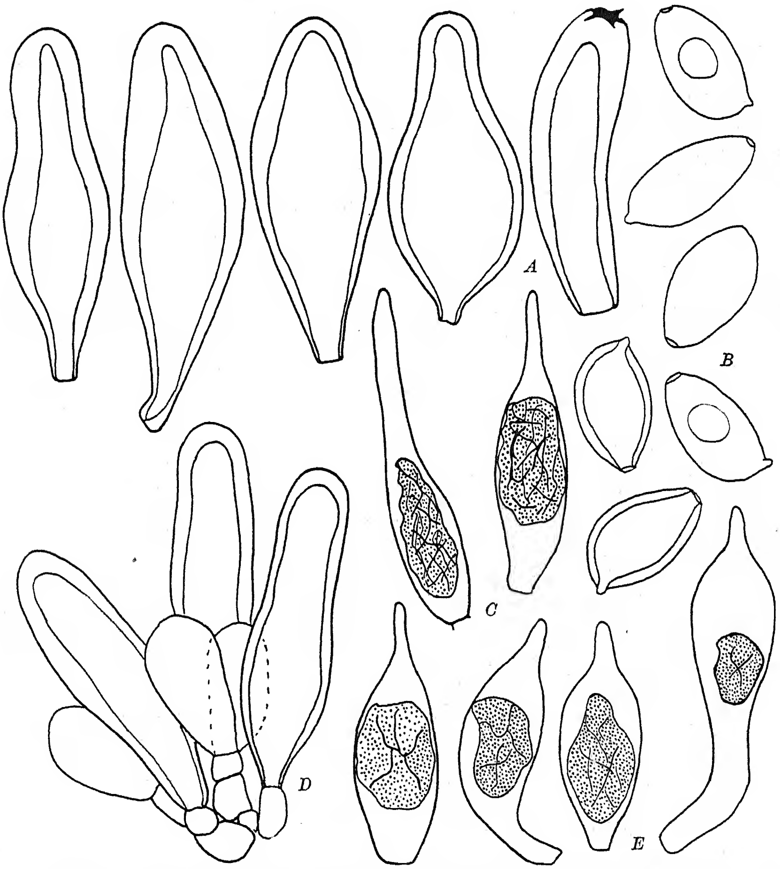

FIG. 2. *A, D, Inocybe luteifolia; B, C, E, Hypholoma anomalum.*

tawny; flesh comparatively firm and brittle, pale buffy yellow, odor nauseating (not spermatic), taste very disagreeable; lamellae narrow, crowded, adnate, "amber yellow" to "mustard yellow" (clear pale yellow) at first, changing to "Sudan brown" at maturity (bright yellowish brown), edges thickish and staining brownish when bruised, even; stipe 3–5 cm. long, 3–5 mm. thick, equal,

solid, white within, surface densely pruinose over all at first, color near "cream buff" (pale buff) above, yellowish below, soon staining bister where handled and in age darkening over all except the extreme apex; spores subovoid, 6–8 × 4–5 μ, smooth, rusty brown under the microscope; basidia four-spored; pleurocystidia very abundant, 35–45 (52) × 10–15 μ, dark yellow in water mounts, thick-walled, subcylindric to conspicuously ventricose, the apices obtuse and usually slightly encrusted; cheilocystidia similar to pleurocystidia or saccate, the latter either thin or thick-walled, yellow in water mounts and measuring 25–36 × 10–14 μ.

Gregarious under aspens at the edge of a bog, Oak Hill Road, Oakland Co., Mich., July 17, 1937 (*6557*-type). It was also found at Ann Arbor, Washtenaw Co., Mich., July 30, 1937 (*6703*) and at Cades Cove, Tenn., in the Great Smoky Mts. National Park, Aug. 16, 1938.

I. luteifolia is well characterized by its yellow gills, the color change exhibited by them, the evenly pruinose stipe which becomes bister upward in age, the nauseating odor and disagreeable taste, small spores and short pleurocystidia which are yellow in water mounts of fresh material. It is readily distinguished from such species as *Inocybe hirtella* Bres. *Inocybe ochraceomarginata* Kauff. and *Inocybe confusa* Karst by the characters mentioned above. *I. hirtella* as illustrated and described by Lange (4) apparently has gills with a strong tinge of yellow, but its stipe does not darken, its spores are larger, and apparently there is a difference in the color of the fibrils on the pileus as well as a difference in the odor and taste.

Tricholoma cystidiosum sp. nov.

Pileus 1–3.5 cm. latus, conicus vel obtusus, demum campanulatus, siccus, fibrillosus, subrimosus, demum fibrillose squamulosus, albidus; lamellae adnatae, latae, confertae, albidae; stipes 3–5 cm. longus, 2–4 mm. crassus, solidus, equaliter, glaber, albidus; sporae 7–9 (10) × 5–6 μ; cystidia crassitunicata, subventricosa, 40–60 × 10–16 (22) μ. Specimen typicum legit prope McKenzie Pass, Ore., Oct. 23, 1937, A. H. Smith, n. *8118*, in Herb. Univ. of Mich. conservatum.

Pileus 1–3.5 cm. broad, obtusely conic at first, the margin slightly incurved, expanding to broadly campanulate or plane, often with a pronounced conic umbo, the margin long remaining decurved, sometimes recurved in age and subrimose, surface dry and lacerate

scaly near the margin, innately appressed fibrillose over the remainder, for a time the extreme margin decorated with the scattered remains of the thin white fibrillose partial veil, color evenly pure white, unchanging, tinged slightly with buff when dried; flesh white, thin, firm, odor and taste not distinctive; lamellae close but distinct, adnate, becoming adnexed, moderately broad, thin, pure white, edges even; stipe 3–5 cm. long, 2–4 mm. thick, solid, equal, occasionally the base slightly enlarged, fibrous and stringy within but fragile and breaking easily, glabrous or slightly silky, pure white, unchanging; spores 7–9 (10) $\times$ 5–6 μ, subovoid, hyaline, smooth, yellow in iodine; basidia four-spored; pleurocystidia scattered, hyaline in KOH, thick-walled, apices usually encrusted, 40–62 $\times$ 10–16 (22) μ, subventricose to subcylindric, occasionally subovoid, pale yellow in iodine; cheilocystidia of two types, either similar to pleurocystidia or thin-walled and saccate, both types abundant; gill-trama interwoven, yellowish in iodine; pileus-trama homogeneous, yellowish in iodine.

Gregarious under *Pinus ponderosa,* Saginaw Forest, Ann Arbor, Mich., Sept. 29, 1936 (*4958*), and in the Deschutes National Forest, near McKenzie Pass, Ore., also under *Pinus ponderosa,* Oct. 23, 1937 (*81180*-type).

T. cystidiosum is very similar in stature to *Tricholoma myomyces* sensu Lange. It differs from all species of the *Tricholoma terreum* group, however, in the presence of thick-walled cystidia on the gills. Superficially it closely resembles *Inocybe geophylla* (Fries) Quél. It has the same stature as our western form of the latter, the same type of fibrillose veil, the same cystidia, and spores of the same size and shape. The spores differ only in their thinner unpigmented walls. Both were found together, and their resemblance was so striking in the field that I considered the *Tricholoma* to be merely a sterile form of *I. geophylla.* The white spore deposit, however, quickly proved that the specimens in question were neither sterile nor an *Inocybe.* Although thick-walled cystidia have not been previously known for species of *Tricholoma,* the character scarcely seems important enough to justify erecting a genus to include the one species.

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DESCRIPTION OF FIGURES

The drawings of the cystidia and spores were made with the aid of a camera lucida. The drawings of the cystidia are reproduced at approximately 1250 ×; those of the spores at approximately 1550 ×. All of the drawings were made from type material.

FIG. 1, *Inocybe cinnamomea: A,* four pleurocystidia; *B,* three cheilocystidia; *C,* nine spores. *Inocybe insignis: D,* seven spores; *E,* three pleurocystidia; *F,* two pleurocystidia. *Inocybe luteifolia: G,* nine spores.

FIG. 2, *Inocybe luteifolia: A,* five pleurocystidia; *D,* a cluster of cheilocystidia. *Hypholoma anomalum: B,* six spores; *C,* two pleurocystidia; *E,* four pleurocystidia.

NOTES ON SOME NEW OR INTERESTING FUNGI

David R. Sumstine

Hydnum strigosum Fries.

This species was collected near Leechburg, Pennsylvania, on an old log, October 8, 1938. A section cut from the thicker part of the plant revealed the characteristic stratum of this species. Miller (Mycologia **26**: 218. 1934) accepts the combination *Gloiodon strigosus* (Fries) Karsten as the proper interpretation of this species. It is not frequently reported.

Phyllosticta Asiminae Ellis & Kellerm.

A fungus on the leaves of *Asimina triloba* (L.) Duval was collected near Reedsville, West Virginia, September 3, 1938. It agrees with the description of *Phyllosticta Asiminae* Ellis & Kellerm. given by Seaver (N. Am. Flora **6**: 43. 1922) with the exception of the spores which are said to be subglobose to ellipsoid or oval 5–6 × 7–9 μ with granules. The spores in my specimens are elliptic 4–5 × 10–12 μ.

Only one species has been reported on this host. Unless other specimens with similar spores are found the Reedsville specimens may be considered as a variant rather than a new species.

Amanita virginiana (Murrill) comb. nov.

During the summers of 1937 and 1938, I collected a small *Amanita* growing on the grassy plot near the children's playground at Pocono Manor, Pennsylvania. It appeared in abundance after a rain. This plant agrees very well with the description of *Venenarius virginianus* Murrill. The only distribution given by Murrill is Mountain Lake, Virginia, where the type was collected in 1909. The collection at Pocono Manor extends the range to Pennsylvania.

Lactaria glutinosa sp. nov.

Pileus fleshy, convex at first, then depressed in the center, 4–6 cm. broad; smoky gray, darker at center, glabrous, azonate, very viscid in wet weather, covered with a glutinous coat which disappears in drying, margin regular or sometimes sulcate; context white, thin; latex white unchanging, acrid; lamellae white becoming ochraceous in drying, slightly decurrent, moderately distant, with shorter ones intermixed; stipe concolorous or little lighter than the pileus, tapering downward, glabrous, appearing striate at times, solid 3–4 cm. long, 5–15 μ thick; spores white, globose or subglobose, slightly echinulate 5–7 μ; cystidia numerous, cuspidate 70–80 × 8–10 μ. On the ground in mixed woods, Pocono Manor, Pennsylvania, August 12, 1937. Type has been deposited in the Carnegie Museum.

Pileus carnosus primitus convexus demum centro depressus 4–6 cm. latus, fuligineo-griseus, glaber, azonatus, viscidus, glutinosus, margine integro vel sulcato; contextus albidus, tenuis; latex albidus, immutabilis, acris; lamellae primitus albidae demum ochraceae, subdecurrentes, subdistantes; stipes concolor vel pallidior, sensim angustans ad basem, solidus, 3–4 cm. longus, 5–15 μ crassus; sporae albidae, globosae vel subglobosae, echinulatae, 5–7 μ; cystidia numerosa, cuspidata, 70–80 × 8–10 μ.

This species is intermediate between *Lactaria trivialis* Fries and *Lactaria mucida* Burl. From both these species, it differs mainly in color of pileus, in size of spores, and in cystidia. Authentic specimens of *Lactaria trivialis* and *Lactaria mucida* in the New York Botanical Garden do not show any cystidia. The latex in these two species stains the lamellae glaucous-green. The latex in *Lactaria glutinosa* does not stain the lamellae green.

In the herbarium of the New York Botanical Garden, there is a specimen collected by Dr. Murrill at Mill City, Oregon, No. *867*, labeled *Lactaria mucida* Burl. A note with the initials of Murrill indicates a wrong identification. Field notes accompanying the specimens give the following information, "Extremely slimy in rain, fumosus-avellaneous cap and stem; convex to umbilicate; stem hollow; gills adnate, decurrent with tooth, white; milk white, unchanging, slowly acrid; flesh watery."

The spores were found to be elliptical to subspherical, slightly echinulate, 6–8 μ; cystidia 70–80 × 6–8 μ. In color, viscidity, spores, and cystidia, it resembles *Lactaria glutinosa*. However, the long hollow stem is quite different from this species.

Hygrophorus (*Hydrocybe*) **Graciae** sp. nov.

Pileus conic, campanulate with cuspidate umbo, crenate striate, lemon yellow, brown-yellow when dry, 1–2 cm. broad, scarcely viscid, not turning black in drying; flesh thin; lamellae broad, waxy, adnato-decurrent; stipe concolorous or lighter than the pileus, subequal, hollow, 5–9 cm. long, tomentose at the base; spores irregular, angular 8–10 μ.

Pileus conicus, campanulatus umbone cuspidato, crenato-striatus, citrinus dein brunneolus, 1–2 cm. latus, subviscidus, non nigricans; contextus tenuis; lamellae latae, ceraceae, adnato-decurrentes; stipes concolor vel pallidior, subaequalis, cavus, 5–9 cm. longus basi tomentosu; sporae irregulares, angulares, 8–10 μ.

Growing in mossy places in mixed woods, near Kane, Pennsylvania, September 5, 1937, Grace H. Sumstine. Type has been deposited in the Carnegie Museum.

It differs from *Hydrocybe ceracea* in cuspidate umbo and in spores; from *Hydrocybe cuspidata* in color and in spores; from *Hydrocybe conica* in color, in spores, and in not turning black in drying.

COLLYBIA HIRTICEPS Peck and related species.

Peck (Bull. Torrey Club **34**: 98. 1907) described *Collybia hirticeps* from specimens collected at Pigeon Lake, Ontario, by C. Guillet, in August, 1905, and from specimens which I sent him about the same time. The two collections were considered by Peck as identical. Part of my collection is in the Carnegie Museum and marked co-type. Murrill (N. Am. Flora **9**: 375) makes the following statement about this species, "*Collybia hirticeps* Peck (Bull. Torrey Club **34**: 98. 1907). Specimens collected by Burnham in 1908 prove to be *Crinipellis zonata* (Pk.) Pat." This statement may be true of Burnham's specimens but it does not decide the status of the specimens on which Peck described his new species.

Recently in examining my specimens, I find that they agree with the original description. The color of the pileus is brown, "mummy-brown," azonate. The stipe is 5–7 cm. long, tough, equal, tomentose, colored like the pileus or a little paler. The

spores are globose or subglobose, 4 μ. Peck gives the spores as globose or subglobose 4–5 μ long and 4 μ broad.

This species differs from *Collybia zonata* Peck in the brown color, the absence of zones, in the tough (not fragile) texture of the whole plant, and in the shape and size of the spores.

This species is also closely related to the following species: *Collybia campanella* Peck, *Collybia stipitaria* Fries and *Lentinus pulcherrimus* Sumstine. Years ago Dr. Peck sent me specimens of these species for examination and study. After making some notes on the characteristics of these plants, I returned them to him. Later my library with these notes was burned and I was unable to publish the results of the study.

I have examined my own material recently and have read the descriptions of these species given by different authors. I have found some interesting statements of the size of the spores of these species.

COLLYBIA ZONATA Peck. In the original description in Ann. Rep. N. Y. State Museum **24**: 61. 1872, the spores are given as ellipsoid 5 μ long. Murrill in N. Am. Flora **9**: 287 (as *Crinipellis*), states that the spores are ellipsoid 5–7 $\times$ 3.5–4.5 μ.

COLLYBIA CAMPANELLA Peck. In Bull. N. Y. State Museum **116**: 19. 1907, Peck says "spores not seen."

COLLYBIA STIPITARIA Fries. In Sacc. Syll. Fung. **5**: 216, the spores are given as 8–9 μ long. Rea in British Basidiomycetes: 534 (as *Crinipellis*) says the spores are pip-shaped, 10–12 $\times$ 6–7 μ, multi-guttulate. Ricken in Blätterpilze **1**: 417 gives the size of the spores 7–8 $\times$ 4–5 μ and adds that the cystidia are subulate, 30–40 $\times$ 6–8 μ. Murrill in N. Am. Flora **9**: 287 (as *Crinipellis scabella*) records the size as 6–7.5 $\times$ 4 μ.

LENTINUS PULCHERRIMUS Sumstine. In Torreya **7**: 60. 1907, the spores are given as broadly ovate. This species has a very strong odor resembling the odor of *Claudopus nidulans*. The odor is so distinct that anyone collecting this plant could not miss it. No odor has been recorded in any of the descriptions of these other species. I have before me specimens from New Hampshire, Michigan and Pennsylvania and all have this characteristic odor. The spores of these plants are globose to subglobose 2–4 μ. The

spores in the Michigan specimens are a little larger 3–5 μ. These specimens seem to be distinct from the other species.

These five species need further study.

MICROSPHAERA PLATANI Howe and OIDIUM OBDUCTUM Ellis & Lang.

Since 1912, I have been collecting the conidial stage of some species of Erysiphaceae growing on the leaves of the oriental (London) plane tree. Only recently have I found the perithecial stage. My collection includes specimens from Pittsburgh, Gettysburg, and Philadelphia in Pennsylvania and from Camden, Atlantic City, and Ventnor in New Jersey. The specimens from Camden are the only ones with the perfect stage. The perithecia have all the characters of the genus *Microsphaera* and the specimens may be referred to *Microsphaera Platani* Howe. This species is considered by some as a form of *Microsphaera Alni* (Wallr.) Salmon.

The following description of the conidial stage may help to identify it in the absence of the ascigerous stage: Amphigenous, white to sordid white, forming a dense floccose stratum on the leaf; mycelium branched, interwoven; sporophores erect, simple, septate, bearing the chain of spores; spores ellipsoid, barrel-shaped, granular within, variable in size, 15–20 $\times$ 30–50 μ. It attacks both the young and the older leaves of the plane tree. In Overbrook, Philadelphia, it has become a menace to the shade trees. (Vide Mycologia **5**: 59. 1913.)

Ellis and Langlois (Jour. Myc. **6**: 35. 1890) described a new conidial species, *Oidium obductum*, growing on *Quercus* (*falcata*?) in Louisiana. This species has also been reported on *Platanus*. An examination of some of the original collection on *Quercus* from Louisiana shows that the fungus on *Platanus* in my collection is different from *Oidium obductum*. Salmon (Ann. Myc. **3**: 493–595. 1905) combines *Oidium obductum* with *Phyllactinia corylea* var. *angulata*.

STEREUM MURRAYI (Berk. & Curt.) Burt.

This *Stereum* is widely distributed in America and is reported as growing on frondose species. But, in Europe, it is also found

on conifers. In my collection from Cook Forest, Pennsylvania, I find it growing on pine logs. This seems to be an unusual host for this species in America.

RHINOTRICHUM LAEVISPORUM (Cooke) Sumstine.

During the winter of 1939, I collected this species in Florida. It has been very seldom reported since the first discovery in 1878.

CARNEGIE MUSEUM,
PITTSBURGH, PENNSYLVANIA

NOTES ON BOLETES. VI

Walter H. Snell and Esther A. Dick

During the last three summers the senior author has unfortunately found himself in sections of the country in which the weather was extremely dry and unfavorable for the growth of fleshy fungi. Nevertheless, many interesting collections have been made and certain problems in the *Boleti* have been cleared up. In addition, specimens sent in by other collectors have provided valuable facts, as well as new species.

SPECIES REDISCOVERED

Boletus acidus was described by Peck in 1906 from a collection under pine and hemlock at Port Henry, N. Y. He stated that it was closely related to *B. americanus* and *B. punctipes,* and distinguished from these by the whitish color, slight but mostly evanescent annulus, and acid taste. As far as the writers know, a definitely identified specimen of this species has not been collected by anyone else. During the past few years, the senior writer has haunted the white pines around Port Henry in a search for this species, and his efforts were rewarded after belated rains in the latter part of September, 1936. The taste of the flesh of the specimens obtained was not as disagreeably acid as emphasized by Peck, but in all other respects the specimens were readily recognized as distinct from all other known species and they agreed in detail with Peck's excellent description.

Boletinus glandulosus is another species the distinctness and validity of which have been doubted by many collectors of higher fungi. Again, as far as is known to these writers, the only collections are those sent to Peck from Nova Scotia and Friendship, Maine. A good specimen of this species was collected near Littleton, N. H., in 1936, by R. P. Elrod. Thus, another species of this genus can be accepted with confidence, and, further, the range of the fungus is extended. It is to be expected that it ought to be

found under spruce and balsam in Vermont, northern New York and localities in eastern Canada other than the one noted. It is easily recognized by the prominent glandular dots on the walls of the tubes.

RARE SPECIES FOUND AND RANGES EXTENDED

Following the mycological foray at Mountain Lake, Virginia, in 1936, Dr. C. L. Shear and his son invited the senior author to visit an unusually prolific collecting area in a stand of very old oak and white pine near Blacksburg, Virginia. Here, as elsewhere, because of the drought almost nothing was found except one small collection of *Paxillus corrugatus* on a prostrate trunk of what appeared to be white pine, and *Boletus Betula,* which surprisingly occurred in great abundance.

Boletus alboater Schw. apparently cannot be considered as a rare species, but it so happens that these writers have seen it only twice prior to 1936. In that dry season, however, it was collected in comparative abundance in Pennsylvania and Virginia, in situations where ordinarily common species were rare or absent.

Boletus multipunctus, collected by Peck at Bolton, N. Y., and *B. fulvus,* collected by McIlvaine in West Philadelphia, Pennsylvania, and named by Peck, have not been found since the original collections, except for a record of the latter species in Canada. Both were found by the junior author, the former near Reading, Pennsylvania, and the latter near Ashburnham, Massachusetts.

Boletus variegatus Swartz appears to be fairly common in Europe, but it has not been well understood in this country. Peck apparently never saw it, but in his account of the Boleti he gave it as reported from North Carolina by Curtis and Schweinitz, from California by Harkness and Moore, and from Rhode Island by Bennett. McIlvaine reported it as "quite common on flat benches where hummocks and spruces have grown," in the West Virginia mountains, in New Jersey and Pennsylvania. In correspondence, Miss Elizabeth Morse has confirmed the occurrence of this species in California. The authenticity of the Bennett report for Rhode Island has been questioned, because of what have proved to be misconceptions of many of the species of fungi in his day, to say nothing of lack of herbarium specimens to sub-

stantiate his reports. Recently, however, confidence in this report has been restored. This bolete has not been found again in Rhode Island, but some specimens collected a few years ago in Middleboro, Massachusetts, by Mrs. Florence H. Hayward, have been identified with certainty as *B. variegatus.* This species has some features in common with *B. subtomentosus,* but is usually larger and flatter, and has a surface that is fibrillose to more or less dark-scaly after the original tomentum disappears. The pores in the specimens mentioned above are larger than those reported in European descriptions, but otherwise there are no differences.

Boletus duriusculus Schulz. was listed by McIlvaine from Snow Hill, New Jersey, in 1892, but it has not been recognized by anyone else in this country. Its occurrence in America was confirmed by a specimen sent in from Ohio by William Bridge Cooke, if our determination is correct. It would seem that there can be no mistake, because this species is the only one of the known Boleti in which the flesh turns a coppery-reddish or salmon-orange when cut.

Boletus niveus Fries (=*B. holopus* Rostk.) apparently has been recognized only occasionally in this country. For years the present authors did not find it, but it has been turning up once in a while in recent summers. Several collectors found it during the 1938 Foray at Duchesnay, Quebec. It is without doubt what has been considered a white variety of *B. scaber,* but the pellicle of *B. niveus* is fibrillose while that of *B. scaber* is made up of globulose cells. We are convinced that *B. albellus* Peck is *B. niveus.* The spores and cystidia are the same in the two species, and the glabrous stipe of *B. albellus* is only a variation.

Boletus niveus seems to be a northern form in America. While we have a record of its presence in Pennsylvania, it is usually collected in northern New England and New York, and in Canada. It has been found in Labrador and recently there came to our attention two specimens from farther north—one collected by H. M. Raup near Lake Athabasca in the Province of MacKenzie, north of latitude 60°, and the other collected by J. Aughton, and communicated by H. S. Jackson, from Lake Harbour, Baffin Island, at about latitude 62° or 63°.

Boletus mirabilis Murrill, originally described from Washington

and Oregon and reported also from Manitoba (no. V of these Notes, Mycologia **28**: 363. 1936), was found in Pennsylvania by L. O. Overholts.

Boletus pseudodecorus, first described by the authors from Mt. Gretna, Pennsylvania, has been found in some abundance at certain times on the campus at State College, Pennsylvania, by L. O. Overholts. It was also located recently in Rhode Island. Since the original study of this supposedly new species, it has been noticed by the senior author that Frost's brief description of *B. ferrugineus* would fit our fungus. There has thus far been no opportunity to study Frost's specimens at Burlington, Vermont, but in any event the newer name will stand, since Frost's name is preoccupied by Schaeffer's *B. ferrugineus,* which is a synonym for *B. spadiceus* Schaeff. ex Fries, according to all the European accounts.

Boletus pulverulentus Opat. (of which *B. mutabilis* Morg. is a synonym), *B. porphyrosporus* Fries and *B. calopus* Fries, known heretofore as occurring only from the east coast to the Mississippi, were sent in from the west coast by Alexander H. Smith—all three from Washington and the first two also from California.

Boletinus cavipes (Opat.) Kalchbr. was sent in by D. E. Stuntz from Washington on the west coast at an elevation of 4000 feet, and by V. L. Benton from Idaho. This is the first time the writers have known of it west of Manitoba. Along with Stuntz's collection were some unusual specimens that seemed to be nothing but this species, but with pileus distinctly rosy-red to bright red (Nopal red and Eugenia red of Ridgway) and with the spore print purplish-reddish-brown. This is the first time anything like this has been found as far as is known. For present purposes at least, it is being called *forma rubrotinctus.*

Specimens determined to be *Boletus americanus* Peck were sent in from Washington by A. H. Smith, and from Idaho by V. L. Benton.

NEW SYNONYMY

Boletus tomentosus Kauff. is to be considered the same as Peck's var. *mutans* of *B. hirtellus.* The only difference between *B. tomentosus* and *B. hirtellus* is the slightly whiter flesh which turns blue; the variety was established to include this character. The

name *tomentosus* would have to be given up at any rate, because of its previous use by Krombholz for another species (*B. ferrugineus* Schaeff.).

The name *crassipes* was given by Peck to a specimen sent from Mt. Gretna, Pennsylvania, by McIlvaine. Peck said "the thick, beautifully reticulated stipe, the deep velvety-brown color of the pileus and the deep yellow color of the flesh serve to distinguish this species"—obviously chiefly from *B. auripes* Peck. Both the present writers have each made several visits to Mt. Gretna to search for *B. crassipes*. On one trip, the senior author found some specimens that he identified as *B. auripes*, although they were a little dingy and moldy. Some time later, while looking through McIlvaine's tome, he ran across the colored drawing of *B. crassipes*, by this time forgotten, and there to the minutest detail was his *B. auripes* from Mt. Gretna. This is not the most decisive evidence that could be obtained, but until some more distinctive characters than the thickness of the stipe (which is really all that is left of Peck's statement) can be found, the species *crassipes* will be dropped.

There has long been puzzlement over *B. scabripes* described by Peck from specimens collected by Miss White at Bar Harbor, Maine. This species was distinguished by the tubes becoming black on drying and exuding a black juice with a strong odor, and with stipe adorned with numerous, projecting sharp black points. The senior author has made special efforts to find it, to the extent of making trips to Bar Harbor for this purpose alone. Specimens that seemed to have some of the characters of the species always turned out to be something else. Finally, on one of the recent visits to the Peck Herbarium in Albany, the type specimen of *scabripes* suddenly took on familiar appearance—that of *B. eximius*. Study of the characters of the fruit body and microscopic examination of the tissues, cystidia and spores supported the idea, as did also a reëxamination of a copy of Miss White's original drawing in the New York Botanical Garden. In this drawing, except for the somewhat greater sharpness of the scurfy agglomerations on the stipe, there was portrayed a fruit body that had all the features of a rather old, possibly moldy or rain-soaked specimen of *B. eximius*. Specimens of this species in such conditions

do exude a blackish fluid. Hence, unless and until some *Boletus* of this sort can be found with distinct differences from *B. eximius,* the species *scabripes* will be discarded.

BOLETUS BICOLOR AND B. MINIATO-OLIVACEUS

Collectors apparently experience considerable difficulty in distinguishing these two species, especially by means of the keys and descriptions available. There has been no question about the variety *sensibilis* of *B. miniato-olivaceus,* because the entire carpophore changes immediately to deep blue upon contact or wounding. There are only three other species of Boleti which are equally sensitive—*B. purpureus, B. pulverulentus* and *B. cyanescens.* The first one is distinguished by a reticulate stipe and red tube mouths, the second by reddish-brown to dark-brown pileus and roughened stipe, and the third by whitish to yellowish color, hollow stipe, tubes at first white, and yellow spore print.

Likewise, there has been question about *B. bicolor* only when this species has become much faded or quite yellow. Its pileus is characteristically apple-red from the first until late maturity, and the stipe is mostly red, but yellow above.

The difficulty in identifying the typical form of *B. miniato-olivaceus* is traceable to the current descriptions. All of these state that the pileus is at first vermillion and then olivaceous or perhaps ochraceous-red. For years this coloration was searched for and never found. In the experience of the present writers, the pileus is never vermillion and seldom olivaceous. It is at first deep rose-color or reddish-rosy, soon showing various combinations of bright red, pinkish-red, pinkish, ochraceous and bright yellow, with only occasional tinges or spottings of olivaceous. The stipe differs from that of *B. bicolor* in being mostly yellow, but tinged more or less red in the middle portion, or perhaps at the apex.

Parenthetically, concerning *B. bicolor,* Kallenbach thinks that this species of Peck's is the same as *B. sanguineus* With. of Europe. The descriptions of the two certainly read alike, but it is hoped that European specimens can be examined before the synonymy is agreed to. Furthermore, the epithet *bicolor* was used by Raddi in 1807 for a species now unknown.

THE A. M. SPORE NUMBER

Any specialist in any of the groups of the higher fleshy fungi can testify to the difficulties in identifying dried specimens sent in by correspondents. While some consignments arrive in excellent condition and with copious descriptive notes (and occasionally even with water-color drawings), on the other hand many are received with the specimens immature, overmature, worm-eaten, poorly dried or even badly broken, and accompanied by no notes at all or with inadequate notes, especially as to color and important changes of color. Some specimens received have been in the herbarium for 85 years. In the case of the Boleti, it is surprising how many different species can have the same appearance in the dried or aged condition, to say nothing of the situation presented by improperly dried material, in which all evidence of the original color is lost, if the specimens are not quite black and even the surface characters obscured or possibly cooked away in improper drying.

In the first attempts to develop some procedure which would enable the writers to identify poor specimens, or even a fragment when necessary or desirable, single definitive characters were listed as far as they were available, and then the remaining species were classified by groups according to various superficial characters, for the purpose of narrowing the choices or even of arriving at a definite determination after several eliminations on the basis of the several chosen characters had been made. The basic data for this procedure were of the sort presented as " Some aids to rapid identification " in " Tentative Keys to the Boletaceae of the United States and Canada " by the senior author. While this method saves a great deal of time and works out reasonably satisfactorily, it has been felt by the senior author that the use of spore characters might give more definitive and more precise results, even though it was realized that the spores of most species of the Boletaceae are remarkably similar in color, shape and size, especially as sizes are ordinarily given in terms of range. There is no possibility of using color and shape of spores for the determination of species in this family, except secondarily. Ornamentation of the epispore can be used to identify *Strobilomyces strobilaceus, Polyporoletus sublividus, Boletus Ananas, B. Russellii, B. Betula* and *B. chrysenteroides.* For the remaining species of the Boletaceae,

with smooth epispore, the task appeared hopeless, because at least 75 per cent of the species have their ranges between 9 and 16 microns in length. A study by the senior author of the sizes of the *majority* of the spores, however, gave encouraging results and led to the development of the concept of the **A. M. Spore Number.**

Actually, this "A. M. Spore Number" consists of two index numbers representing the *averages* of the lengths and of the widths of the *majority* of the spores of a species. For example, the spore measurements of *Boletus granulatus* are recorded as "6–10 × 2.5–3.5 μ, mostly 6–7 × 2.5–3 μ." Ignoring the range measurements, the majority of the spores measure 6–7 × 2.5–3 μ. The averages of these latter sizes are 6.5 and 2.75. The "A. M. Number" for this species is therefore taken as 6.5—2.75. Similar compound numbers were made out for all the smooth-spored species of the family and these were arranged in numerical order in an index. It was naturally to be expected that in several instances from two to six or eight species were found to have identical A. M. numbers. Therefore, shape and color characters of the spores were added for the distinguishing of these.

Success with the use of this device obviously depends upon the preciseness of the A. M. Number for a given species, both as originally determined and presented in the index, and as arrived at after the measurement of the spores of the specimen being studied. With regard to the originally determined number (the key number), it has been found that while for most species the majority of the spores will fall within the same limits from specimen to specimen and from year to year, on the other hand there are certain limitations. For one thing, it is quite likely that the A. M. Number, if not the entire range in size, for a species may vary with the locality or environment—for instance, as between the north and south, and the east and west of this continent, or between sea level and higher elevations. For another thing, there are certain species in which, on the basis of our present information, there is not uniformity in this respect. For example, in *Boletus aurantiacus* and especially, *B. auriporus,* the extreme ranges are reasonably constant, but the majority limits vary somewhat. In *B. aurantiacus,* most of the spores may be 14 μ long in some collections, 15–17 μ long in others (A. M. Numbers 14 and 16 for length respectively);

in *B. auriporus,* 8–9 × 4 μ in some, 10–11 × 4–4.5 μ in others (hence, A. M. Numbers 8.5–4 and 10.5–4.25 μ, respectively). Accordingly, two different A. M. numbers are inserted in the index for certain species. It just so happens that in most cases in which two numbers are necessary, dried specimens can be readily identified without recourse to the A. M. Number.

With regard to the accuracy of the number obtained for a specimen under study, it is not difficult to make accurate measurements of the predominating sizes of the spores in a microscopic field and hastily to construct the A. M. Number.

This device is of very great value in certain situations. For example, there are a few groups the individual species of which are readily separable when collected in good condition, but when the fruit bodies are old or faded or rain-soaked and especially when dried, they may have very much the same appearance. Furthermore, the ranges of the spore measurements may be very similar. A group of species which often presents these difficulties includes *B. subaureus, B. americanus* and *B. punctipes.* The last species when young and fresh may be quite yellow like the other two, and when very young the peculiar character of the glandular dots of the stipe may not be evident. *B. subaureus* may be very light yellow at times and *B. americanus* may be darker yellow and lacking in the vermillion streaks. And further, the spore ranges are as follows: *B. subaureus*—7–10 × 3–4 μ; *B. americanus*—8–11 × 3.5–4.5 μ; *B. punctipes*—9–11 × 3–4 μ. With these species, the use of the A. M. Number has been found to be indispensable. For example, these numbers are respectively 8–3, 9–4, 10–3.5 μ.

Obviously, however, the method is not universally infallible. It is most likely to fail when mounts obtained from scratchings of the tube layer contain varying numbers of unshed, immature spores. Even under these conditions the number obtained is precise in over half the cases, and when mature spores are available, especially in a print, the determination is absolutely definitive in about 90 per cent of the trials. When the agreement is not precise, inspection of the A. M. numbers a half a unit (half a micron) or so on either side of the number in question will usually lead to the correct determination. At the worst, the calculated number shows the general neighborhood in the index where the species belongs, and

the use of readily observed superficial characters of the dried fruit body will eliminate species one by one and lead to a proper determination.

So well does this device work, it is now the practise of the authors to begin the process of identifying an unknown, dried bolete by determining the A. M. number, then to check the characters of the sporophore at hand with the description of the species indicated by the number, and finally, as a precaution, to eliminate the other species with only slightly differing A. M. numbers. This method is much less laborious than the use of the senior author's own keys. Whether or not other individuals would have the same success with these index numbers is a question, in view of personal scientific idiosyncracies and mental habits, but for the present writers and with this particular group of fungi, this procedure is in the nature of a godsend in attempting to identify dried specimens unaccompanied by descriptive notes.

NEW SPECIES

In Notes V (Mycologia **28**: 465–466. 1936), among three new forms of *B. felleus* was *f. plumbeoviolaceus.* These "Leadville-colored" (Maerz and Paul, Dictionary of Color) sporophores had been found occasionally for several years, but usually in immature stages. The sporophores are very hard and firm, especially when young, and mature their spores and display the characteristic incarnate color of the tubes only after a rather prolonged period. Recently, however, mature fruit bodies of this bolete have been found and the spores as well as the above-mentioned characteristics set it off as a species distinct from *B. felleus* and all other species.

Boletus plumbeoviolaceus sp. nov.

Pileo convexo, sicco, e subvelutino glabro, e plumbeo-violaceo violaceo-brunneo, 5–11 cm. lato; carne firma, alba, sapore felleo; tubulis e subdecurrentibus adnatis, longum albis, demum incarnatis; poris minutis; stipite subclavato, levi vel obscure reticulato, glabro; sporis incarnatis, e subellipsoideis subfusiformibus, sub lente hyalinis, 7–11 × 2.8–3.5 μ.

Pileus hard and firm when young, convex, 5–11 cm. broad. Surface dry, with a fine velvety appearance when young which borders upon the subtomentose but is not, soon becoming glabrous;

quite violaceous when young, becoming dull violaceous-purplish-gray ("Leadville color" of Maerz and Paul), then more or less violaceous-brown. Flesh hard and firm, very much so when young, white, often purplish under the outer surface, unchanging; odor more or less butyraceous, taste bitter. Tubes adnate, perhaps slightly decurrent, white at first and remaining so for a long time and maturing their spores and becoming rosy only very slowly, unchanging; mouths subrotund, minute, 2–3 a mm. Stipe tapering upward or clavate, even or only very slightly reticulate, glabrous, white to violaceous or brownish, often streaked, often brown at the base; within very firm, white, unchanging; 4–9 cm. long, 1–4 cm. thick. Spores flesh-color in mass, subelliptical to barely fusiform, many more or less fusiform at one end, hyaline, 7–11 $\times$ 2.8–4 μ, mostly 8–9 $\times$ 3 μ. Cystidia common, lageniform, single and hyaline or clustered and brown, 30–40 $\times$ 7–9 μ.

Single or subcaespitose under oaks and in oak mixtures. Rhode Island and New York to Tennessee. August. No. *102* in Bolete Herb. WHS.

In the newer European classifications, this species will be *Tylopilus plumbeoviolaceus.*

Boletus frustosus sp. nov.

Pileo convexo, ad centrum depresso, frustoso, brunneo, subglabro, vix subtomentoso, 7–18 cm. lato; carne albida vel albido-flava, rubrotincta; tubulis adnatis, separantibus, e flavovirentibus flavis, cyanescentibus; stipite subcylindrico, tenuiter reticulato, brunneo; sporis echraceo-brunneis, subfusiformibus, sub lente pallide flavovirentibus, 11–15 $\times$ 4–5.5 μ.

Pileus convex to subhemispherical, perhaps depressed, 7–18 cm. broad. Surface dry, broken up into large frusta, subglabrous, scarcely subtomentose, yellowish-brown or grayish-brown. Flesh solid, whitish to whitish-yellow, perhaps with reddish tinge, unchanging; odor just off the normal mushroom odor, taste bitter. Tubes adnate, separating, 2–4 cm. long, yellow to greenish-yellow, readily changing to blue when bruised; mouths yellow, subangular, medium to large, .7 to 1.5 mm. broad. Stipe very thick, subcylindric or ventricose, usually with a fusiform base, finely reticulate most of length, pruinose-furfuraceous to almost subtomentose above, glabrescent below, often fibrillosely cracked, brown, tinged red at the apex, cracks yellow; within whitish to whitish-yellow, red at the base, tinged red throughout, changing to blue only in center; 3–13 cm. long, 4–9 cm. thick. Spores ochraceous-brown in mass, subfusiform, mostly narrowed at the distal end to almost

pointed, pale greenish-yellow, 11–15 × 4–5.5 μ, mostly 13–14 × 4.5–5 μ. Cystidia single on walls, or clustered at the mouths, clavate, fusiform or lageniform, hyaline or colored, 25–35 × 8–12 μ.

Under Shasta red fir, Mt. Shasta, California, elevation 7500–8000 feet. August. No. *962* in Bolete Herb. WHS, no. *8637* in Herb. Wm. Bridge Cooke. Comm. Wm. Bridge Cooke.

This species belongs in the Calopodes and is easily recognized by the large, yellow-brown fruit bodies more or less covered with large subpyramidal frusta, and thick, finely reticulated stipe.

Boletinus flavoluteus Snell, sp. nov.

Pileo plano-convexo vel plano, subviscido, squamuloso vel fibrilloso, flavo-luteo, saepe cinnabarino tincto; carne subflava, rubrotincta; tubulis adnatis vel subdecurrentibus, e flavis ochraceis; stipite flavo, glandulopunctato; sporis ochraceo-brunneis, ellipsoideis, sub lente hyalinis, 7–9 × 2.5–3 μ.

Pileus plano-convex to nearly plane, 5–7 cm. broad. Surface more or less viscid, squamulose on disc to fibrillose-squamulose toward margin, golden to dull yellow with scales brownish to reddish-brown, vermillion in places. Flesh firm, pale yellow becoming dull yellow, tinged reddish or greenish in places; odor inconspicuous to sweetish, taste inconspicuous to slightly farinaceous. Tubes convex, adnate or perhaps slightly decurrent, golden yellow becoming ochraceous in age or upon drying, 2–3 mm. long; mouths medium to large, angular, more or less compound and radiately arranged, with a few separating veins, glandular-dotted, concolorous. Stipe stout, tapering downward, golden yellow becoming dark yellow to more or less brownish, with occasional touches of vermillion, covered full length with ochraceous to brown glandular dots; within solid, fibrous, deep yellow, tinged greenish at apex and purplish-red at base; 4–5 cm. long, 15–20 mm. thick. Spores pale ochraceous-brown in mass, elliptical, hyaline, 7–9 × 2.5–3 μ, mostly 8–8.5 × 2.5 μ. Cystidia not abundant, single or clustered, cylindric to clavate or irregular, hyaline to colored, 35–50 × 4–7 μ.

Solitary under hemlock-hardwoods. Riverside, N. Y. September, following cold weather and frost. No. *95* in Bolete Herb. WHS.

This species was collected for the only time several years ago, but the description of it was withheld for further observations. It appeared in general so much like *Boletus americanus,* that it was

wondered if possibly the differences might be the result of responses to the cold weather and frost. No other collections of the species have been made, but *Boletus americanus* has been studied in the same place and under the same conditions, and has always been found to be typical and without any such modifications.

This species differs from *Boletus americanus* in the squamulose pileus, decidedly boletinoid tube-layer with separating veins, occasional green tinges of flesh and reddish flesh at the base of the stipe, and smaller, hyaline spores. It differs from the other two yellow species of *Boletinus* (*B. decipiens* and *B. appendiculatus*) by its glandular-dotted stipe and size of the spores, even when the evanescent annulus of the former and the appendiculate margin of the latter are inconspicuous.

Boletinus ochraceoroseus Snell, sp. nov.

Pileo convexo, sicco, fibrilloso-squamuloso, roseo, fibrillis subluteis, 6–14 cm. lato; margine appendiculata; carne firma, subflava; tubulis decurrentibus, brevibus, boletinoideis, venatis, e obscure flavis flavo-brunneis; stipite venoso-reticulato, piloso-velutinoso, glabrescente, annulato, subluteo et roseo; sporis ochraceobrunneis, ellipsoideis, sub lente flavovirentibus, 8–9.5 × 2.8–3.3 μ.

Pileus convex, margin appendiculate with fragments of the veil, 6–14 cm. broad. Surface dry, fibrillose-squamulose, light rose color, with the fibrils or squamules buff. Flesh firm, light yellow, unchanging. Tubes decurrent, short, compound, radiately arranged with separating veins much like *B. porosus* but less prominently so, walls not glandular-dotted under a lens, deep dull yellow becoming deep yellowish-brown, not changing to blue, drying ochraceous to ochraceous-brown, mouths 1–5 mm. broad. Stipe tapering upward, often bent, more or less reticulate or venose-reticulate, usually to annulus, sometimes reticulate below annulus especially when the stipe is short, pilose-velutinous to fibrillose-squamulose in places, glabrescent, mixed buff and rose; within light yellow, unchanging; 4–6 cm. long, 2–3 cm. thick. Veil delicately membranous, whitish-buffish, rupturing to form large portions on the margin of the pileus and a delicate annulus which is at first prominent, then becomes fibrillose fragments and finally almost disappears. Spores rich ochraceous-brown to cocoa-brown [Verona brown to Snuff brown (R)] in mass, narrowly elliptical, pale greenish-yellow, 8–9.5 × 2.8–3.3 μ, mostly 9 × 3 or 3 + μ. Cystidia: (*a*) clustered, especially at the mouths, clavate, hyaline, 30–35 × 5–6 μ; (*b*) on tube walls, single, clavate to irregularly lageniform or hyphoid, hyaline, 50–55 × 5–7 μ.

Under conifers, Smith Creek, Idaho. July. Type in Farlow Herbarium, Harvard University; co-type, no. *893* in Bolete Herb. WHS. Coll. G. P. and R. P. Rossbach, comm. D. H. Linder.

This species is very similar to the testaceous *Boletus Lakei* (which may possibly belong in *Boletinus* rather than in *Boletus*). It differs from the latter species in the following respects: pileus more rosy than testaceous; tube layer very decidedly boletinoid, almost merulioid in some specimens, with very large pores and prominent veins more or less like *B. porosus* instead of slightly boletinoid layer with smaller pores, and drying ochraceous instead of more or less reddish; tube walls and apex of stipe not glandular-dotted; stipe more or less reticulate; spores more slender (8–9.5 × 2.8–3.3 μ, mostly 9 × 3 μ, instead of 7–10.5 × 3–4 μ, mostly 8–9 × 3.5 μ).

Boletinus ochraceoroseus is unique in that in some specimens the reticulation of the stipe extends below the annulus.

Boletinus punctatipes sp. nov.

Pileo convexo, viscido, glabro, margine adpresso-tomentoso, incarnato-brunneo, 5–10 cm. lato; carne alba, sub pelle griseo-vinacea et ad tubulos flavovirente; tubulis brevi-decurrentibus, "warm buff" ad "yellow ochre"; poris glandulo-punctatis; stipite subviscido, apici obscure reticulato, supra glanduloso-punctato, subter glabro, primo albo, deinde stramineo et incarnato-brunneo; sporis ochraceo-brunneis, ellipsoideis, sub lente hyalinis, 7–9 × 3–3.5 μ.

Pileus at first hemispherical, becoming expanded and broadly convex, up to 10 cm. broad. Surface even, very viscid when wet, glabrous except margin which is appressed-tomentose, pellicle entirely separable; pinkish-brown when moist, drying avellaneous at least in spots. Flesh thick, 2–5 cm. in center, firm, compact, tinged grayish-vinaceous under the pellicle and greenish-yellow next to the tubes, otherwise pure white, unchanging; odorless and tasteless. Tubes arcuate, short decurrent, radiately arranged and more or less separated by veins, somewhat glandular-dotted, warm buff, becoming yellow ochre, unchanging, short, 5–6 mm. long; mouths grandular-dotted, irregular, generally oval, elongated radially, medium to large. Stipe equal or tapering upward, very obscurely reticulated at the apex, with a subviscid pellicle which becomes minutely areolate on drying, glandular-dotted on the upper half or so, glabrous below, white when young, remaining white above or becoming straw-yellow, pinkish-brown below, with the dots

brownish-vinaceous; within solid, hard and compact, pure white with base dull vinaceous, unchanging; 5–7 cm. long, 1–3 cm. thick. Spores bright ochraceous-brown in mass, elliptical, hyaline, a few deep olivaceous, 7–10 × 3–3.5 μ, mostly 8 × 3 μ. Cystidia densely clustered, hyaline to dark-colored, cylindrical to somewhat clavate, 40–80 × 6–9 μ.

Under Douglas fir, hemlock and fir. Frying Pan Creek, Washington. August. No. *886* in Bolete Herb. WHS. Coll. and comm. D. E. Stuntz.

A distinct *Boletinus,* with certain characters of the Viscipelles of *Boletus* (*Ixocomus*). Its pileus is very viscid when wet; *B. glandulosus* and *B. flavoluteus* are the only others that are at all so. The stipe is also more or less viscid, like the stipes of these same two species. Its tube walls and mouths are glandular-dotted, as in *Boletus Lakei* and *B. amabilis,* but less so than in *Boletinus glandulosus.* More particularly, the stipe is glandular-dotted; *Boletinus flavoluteus, Boletus Lakei* and *B. amabilis* are the only relatives with stipe thus adorned. *Boletus Lakei* and *B. amabilis* are mentioned in this connection, because it begins to appear that these two species may have to be transferred from *Boletus* to *Boletinus.*

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NOTES ON FLORIDA FUNGI. II

Erdman West

(with 2 figures)

Acrospermum compressum var. foliicolum (Berk.) Riddle.

This anomalous little ascomycete has been reported from several other Southern States but not from Florida. On 27 February 1939 a generous collection of the ascocarps was made on fallen mulberry leaves lying on very wet ground along Hogtown Creek near Gainesville, Alachua County. The honey-yellow translucent clubs were scattered over almost every mulberry leaf in or near the water (F. *22016*).

Ascophanus bermudensis Seaver.

According to Seaver in "The North American Cup-Fungi," this pretty little discomycete is known only from the type locality in Bermuda. On 10 March 1939 specimens were collected on cow dung in Planera Hammock near Gainesville, Alachua County. The apothecia were of the characteristic pinkish white color. Although the ascospores are slightly smaller than the dimensions given in the original description, the distinctive "nail-heads" leave little room for doubt as to its identity. Another character not noted in the original description is the presence of a small knob-like apiculus at each end of newly matured spores (F. *22017*).

Balansia clavula (Berk. & Curt.) Lloyd.

This striking little ascomycete has been collected a number of times in Florida but there seem to be no published records of its occurrence here. Mature specimens were collected by G. F. Weber and the writer 20 June 1934 on *Paspalum ciliatifolium* Michx. near Gainesville, Alachua County. The fungus was collected by the writer on the same host in other parts of Alachua County 21 July 1935 and 10 July 1936 and is apparently not un-

common in this area. On 13 Sept. 1939, typical specimens were found parasitizing the inflorescence of *Paspalum debile* Michx. in a much drier habitat near Gainesville.

A search through the specimens in the Herbarium revealed a packet marked *Balansia* sp. containing a single grass stem resembling *Paspalum ciliatifolium.* It was collected 5 Nov. 1906 by R. Y. Winters at Lake City, Columbia County and bears fruiting bodies of *B. clavula* (F. *2918,* F. *2919,* F. *2923,* F. *20320,* F. *22134*).

BULGARIA RUFA Schw.

This large but inconspicuous rubbery discomycete is not uncommon in the northeastern states but it has never been reported farther south than North Carolina. On 20 July 1938 a small collection of typical apothecia was made on buried wood in Planera Hammock near Gainesville, Alachua County (F. *20321*).

ENTONAEMA LIQUESCENS Moller.

This peculiar tropical ascomycete was collected once on 3 Aug. 1939 on a much decayed frondose log near Gainesville, Alachua County. The large yellowish ascocarps were filled with a watery gelatinous material and appeared immature, but the black punctate mouths of the perithecia were oozing masses of ripe spores. No previous record is known for this species in the United States. The identification was made by Dr. W. W. Diehl (F. *22361*).

KEITHIA JUNIPERI Miller.

This interesting ascomycete was described from material collected near Durham, N. C. No further references to the organism have been found in literature as to its occurrence elsewhere. On 17 March 1940, fruiting material was collected by Dr. G. F. Weber on *Juniperus silicicola* (Small) Bailey at Buzzards Roost in Alachua County. In gross and microscopic characters, the Florida material agrees with the original description, but the host is the southern red cedar (F. *22390*).

PLECTANIA OCCIDENTALIS (Schw.) Seaver.

The bright red, shallow disks of this showy little discomycete were found in considerable numbers in Planera Hammock near Gainesville, Alachua County, 1 Aug. 1938. In an area of mixed oak and pine that had been lightly burned over, the apothecia were attached to partly buried sticks. No previous record of its occurrence in Florida has been found (F. *21097*).

PSEUDOPLECTANIA NIGRELLA (Pers.) Fuckel.

This widely distributed cup fungus has not been reported previously from Florida. Its dull color and inconspicuous habit of growth are probably contributing factors to this situation. Two collections have been made in Alachua County, one at Gainesville 21 February 1939 and one in Sanchez Hammock, about 10 miles away. This latter collection is especially interesting since it grew on a loblolly pine log in advanced stage of decay (F. *3699,* F. *22015*).

SACCOBOLUS KERVERNI (Crouan) Boud.

The dung-inhabiting fungi are very imperfectly known for Florida. So far there seems to be no report of this one for the State, though it has been found in surrounding territory. A collection of typical material was made 18 June 1939 at Gainesville, Alachua County, on weathered cow dung. In this collection the spores are slightly warted as well as reticulated (F. *22356*).

AECIDIUM CYRILLAE Arthur.

Two collections of this rust have been made in Florida; all others reported are from Louisiana and Mississippi. The Florida collections were made 25 April 1938, on *Cyrilla racemiflora* L. on the banks of Hatchet Creek near Gainesville, Alachua County and 23 April 1938 along Blue Springs Run near Marianna, Jackson County (F. *20277,* F. *20278*).

Aecidium rubromaculans sp. nov.

While collecting in a rich hardwood hammock on 26 April 1939, numerous conspicuous spots were noted on a low growing vi-

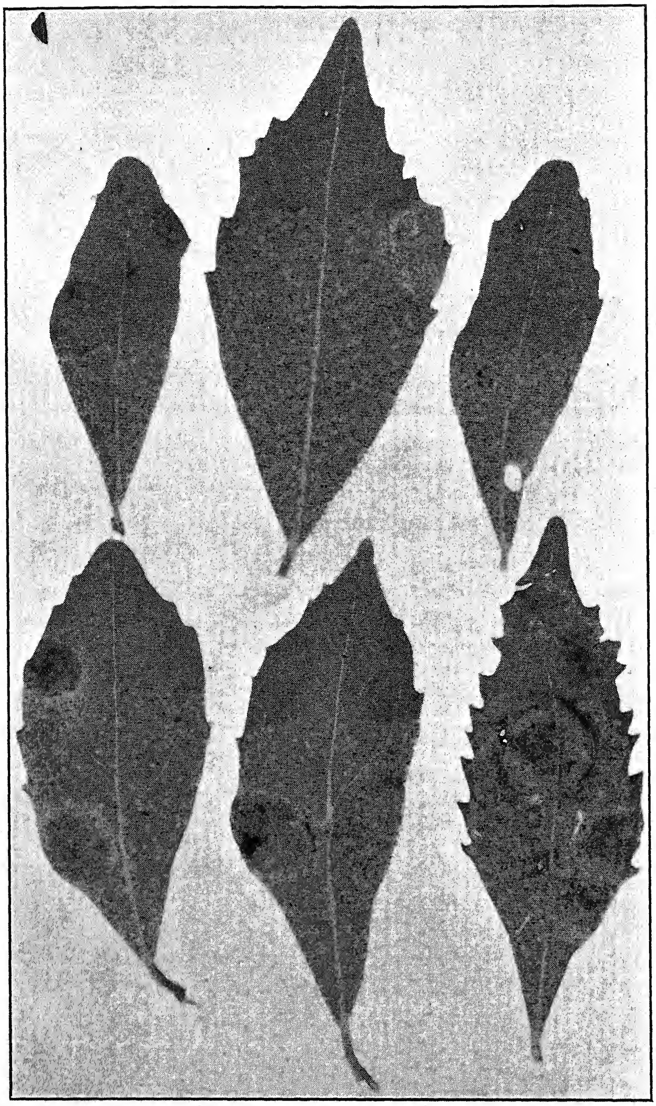

FIG. 1. *Aecidium rubromaculans.*

burnum. At first glance these resembled insect galls but the aecial cups on the under side (FIG. 1) indicated they were due to a rust. Most of the infection occurred within three feet of the ground. Whether this was because the alternate host is low in stature or

because of greater humidity in this zone, it is not possible to say at this time.

Two rusts have been reported on *Viburnum* spp. in the United States. *Puccinia Linkii* Klotzsch producing telia only is reported from the Northeastern part of North America; *Coleosporium Viburni* Arthur is midwestern. As the Florida collection evidently belongs to neither of these, the fungus is considered a new species. Because of the conspicuous red galls that are formed the above name is proposed.

Pycnia are epiphyllous in small dense groups.

Aecia are hypophyllous grouped on dark red round thickened areas 3–7 mm. broad, more or less concentrically arranged, cupulate, peridium soon splitting into recurving segments; peridial cells angular, 16–24 × 22–31 μ coarsely verrucose; aeciospores irregularly globoid, 19–24 × 24–26 μ; wall colorless, 1–1.5 μ thick, very finely verrucose, appearing smooth.

Pycnidiis epiphyllis, copiose evolutis, gregariis.

Aecidiis hypophyllis, in maculis orbicularibus sanguineis, 3–7 mm. diam., cupulatis, margine inciso albo lacerato recurvato; cellulis peridii rhomboideis 16–24 μ longis, 22–31 μ latis, pariete verrucoso; aecdiosporis subglobosis dense minutissimeque verruculosis 19–24 × 24–26 μ, tunica incolori.

Hab. in foliis viburni obovati prope Gainesville, Florida.

On leaves of *Viburnum obovatum* along Hogtown Creek near Gainesville, Alachua County, Florida.

Type deposited in Herbarium, Florida Agr. Expt. Sta. No. F. *22014*.

COLEOSPORIUM LACINIARIAE Arthur.

This fungus is common in the vicinity of Gainesville as the cause of a rust on pine needles in the spring, while the uredinial stage appears on *Laciniaria* in the fall. *Laciniaria elegans* (Walt.) Kuntze and *L. laxa* Small are both very commonly infected. So far as has been found there is no record of the fungus on *L. pauciflora* (Pursh.) Kuntze on which it was abundant 9 Oct. 1939 near Gainesville. This is an early species and it was interesting to note the amount of infection in the inflorescence and even on the bracts of the flower-heads. Coincidentally, the rust was collected 9 Oct. 1935 on *L. spicata* (L.) Kuntze near Starke in Bradford County. This is another unreported host (F. *16684*, F. *22136*).

Phakopsora Zizyphi-vulgaris (P. Henn.) Diet.

This rust was found at Homestead, Dade County, 1 December 1938 by George D. Ruehle.[1] All varieties of the common jujube (*Zizyphus jujuba*) were heavily infected, while the Indian jujube (*Z. mauritiana*) was much less severely attacked. This appears to be the first report of this fungus in America, all previous reports having come from Asia. Only the uredinial stage was found in this instance (F. *22019*, F. *22024*).

Puccinia angustata Peck.

Although *Puccinia angustata* Peck has been reported on various hosts from a wide geographical range, there does not seem to be any specific reference to its occurrence in Florida. It was of interest then to find *P. a. typica* Arthur close to Newnan's Lake near Gainesville in Alachua County 29 June 1938 on *Scirpus Eriophorum,* a hitherto unreported host (F. *21027*).

While examining some specimens of *Rynchospora corniculata* (Lam.) Gray collected in Punta Gorda, Charlotte County, on 24 November 1939, the telia of a rust were noted on many of the leaves. These proved to be *P. a. angustatoides* (R. E. Stone) Arthur, a southern variety according to Arthur's Manual of the Rusts (F. *22357*).

Puccinia Cannae (Wint.) P. Henn.

It seems strange that a relatively common rust on a so well-known host as *Canna* should escape recording for so many years. The first collection in Florida according to our records was made 31 Jan. 1922 by E. O. Hopkins, at Delray, Palm Beach County. In addition to *Canna flaccida* and *C. indica, Thalia geniculata* has been found infected in Manatee County. Other collections on *Canna* are recorded from Brevard, Manatee, Pinellas and Seminole counties (F. *3911,* F. *3912,* F. *3913,* F. *3914,* F. *3915,* F. *16813* and F. *16850*).

[1] Ruehle, George D. The Plant Disease Reporter 23: 40. 1939.

PUCCINIA JUSSIAEAE Speg.

This rust is of common occurrence in Florida on a number of different hosts. A small creeping plant, *Ludwigiantha arcuata,*

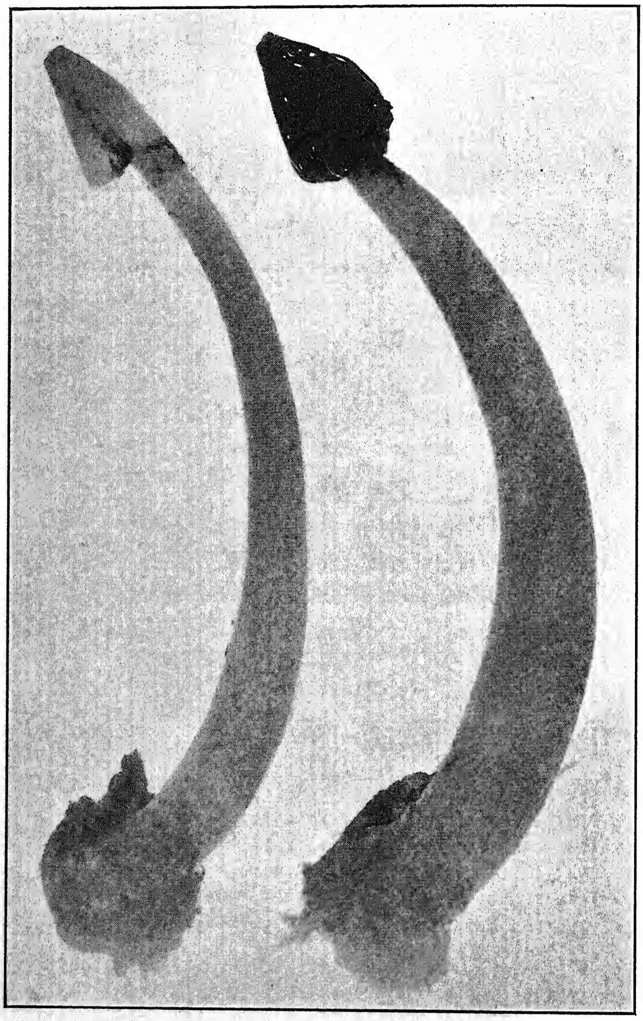

FIG. 2. *Ithyphallus Murrillii.*

that covers large areas of low pasture land, is frequently severely affected. There is no report of this host in literature. *Ludwigia suffruticosa,* an inconspicuous plant in low meadows, is also com-

monly affected. Collections on both these plants have been made in Alachua County, the former 9 June 1935 and the latter 17 June 1938. In addition the rust was collected on *Ludwigiantha* at Ormond, Volusia County, 1 Sept. 1927 (F. *5895*, F. *21052*, F. *21053*).

PUCCINIA KUHNIAE Schw.

Collected on *Kuhnia Mosierii* Small in Alachua Co., 24 Sept. 1939. Also collected in the same county 5 Oct. 1927 on *Coleosanthus cordifolius* (Ellis) Kuntze. This fungus has not been hitherto reported in Florida. No record has been found of its occurrence anywhere on *Coleosanthus cordifolius* (F. *16392*, F. *22135*).

PUCCINIA MINUTISSIMA Arth.

This rust is represented in our collections by one leaf of *Decodon verticellatus* bearing one spot with aecia collected in Alachua County 19 May 1935 by G. F. Weber. All other known reports are from Delaware and northward (F. *16953*).

PUCCINIA SCIRPI DC.

Collected 13 Nov. 1939 by W. B. Tisdale on *Nymphoides lacunosum* in a lake near East Lake, Putnam County. The round patches of aecia were conspicuous by their yellow color in contrast to the dark green of the normal leaf area. The fungus has not been previously reported in the United States and the aecia from Cuba only on *N. Grayanum* (Griseb.) Arthur (F. *22364*).

PUCCINIA SUBSTRIATA Ellis & Barth.

The uredinial stage of this rust is common around Gainesville, Alachua County, on *Paspalum plicatulum* Michx., a hitherto unreported host. A generous collection was made 14 May 1939 (F. *22388*).

PUCCINIASTRUM PYROLAE (Pers.) Schroet.

A package of *Chimaphila maculata* collected at Thurmond, North Carolina, intercepted by the State Plant Board at Jacksonville,

Florida, was found to contain numerous specimens infected with this rust. Arthur's Manual does not list the fungus from the State of North Carolina. The uredinial stage was very conspicuous (F. *22363*).

UREDO GUACAE Mayor.

Rusts on epiphytic orchids are rather rare in the United States although several have been found in greenhouses on collected plants from South or Central America. Very sparse collections of one of the tropical American forms have been made occasionally in Florida but not reported. On 28 April 1940 a generous collection of what corresponds to *Uredo Guacae* Mayor on *Epidendrum tampense* was made at Bradenton, Manatee County, by Miss Lillian E. Arnold. The young uredia form concentric rings around the old initial infections. The rust is probably much more common than the records would indicate. The relatively inaccessible habitat of the host, in the tops of oak and other forest trees, is a decided deterrent to the frequent collection of this rust (F. *22389*).

UREDO LUCUMAE Arthur & Johnston.

This rust was collected on *Lucuma nervosa* A. Dc. at Homestead, Dade County, by George D. Ruehle, 9 February 1937. It has been reported previously from Cuba on this host. This year (1939) the fungus was more abundant than in 1937 [2] (F. *17114, F. 22027*).

This fungus has been transferred to the genus *Acrotelium* by Dr. Geo. B. Cummins [3] since he was successful in demonstrating teliospores.

On 17 March 1939 the same collector found leaves of *Lucuma salicifolia* affected by a rust which proved to be this species. This appears to be the first record for *Uredo Lucumae* on this host (F. *22026*).

UROMYCES ASCLEPIADIS (Schw.) Cooke.

This rust has been collected in Florida on the orange or butterfly milkweeds, but there is no record of its occurrence on other groups.

[2] Ruehle, George D. The Plant Disease Reporter **23**: 40. 1939.

[3] Cummins, G. B. Bull. Torrey Club **67**: 70–72. 1940.

On 28 July 1935 the uredia were found on *Asclepias tomentosa* Ellis at Daytona Beach in Volusia County. There is no previous record of infection of this species. Telia have not been found in our collections (F. *16725*).

UROMYCES KRAMERIAE Long.

This rust has been reported only from Northern Texas on *Krameria glandulosa* Rose and Painter. Only the telia are reported from this collection. On 21 September 1936 the telial stage was collected by Geo. F. Weber near Gainesville, Alachua County, on *Krameria spathulata*. On 12 May 1939 plants of this host species in the vicinity of Gold Head Branch State Park in Clay County were found bearing pycnia, aecia, and uredinia of what appeared to be the same organism. Telia found associated with uredinia on plants in the same area 19 June 1939 correspond perfectly to the species as described by Long.

The pycnia are orange red in color, mostly epiphyllous (occasionally caulicolous) on small inconspicuous yellow galls.

The aecia are produced on the same galls as the pycnia but appear later. They occur on both sides of the leaf surrounding the pycnia on the upper side and are general on the under side of the areas. The aecia are cupulate, shallow, 100–150 μ broad; the peridia pale, erect, soon irregularly lacerate; the aeciospores are angular to globoid, $18–22 \times 19–24\ \mu$; wall colorless, 1 μ thick, minutely but closely verruculose.

The uredinia are amphigenous cinnamon brown, .2–.5 mm. broad; urediospores subglobose to broadly obovate-ellipsoid, $18–22 \times 24–29\ \mu$; wall pale golden-brown sparsely and minutely echinulate.

SEPTOBASIDIUM MARIANI Bres.

This felty fungus was collected on *Crataegus luculenta* at Worthington Springs, Alachua County, on 4 April 1939. No record of the occurrence of this species in Florida has been found. The identification was verified by Dr. John Couch (F. *22013*).

Ithyphallus Murrillii sp. nov.

For several years a red phalloid has been noted during the rainy season in lawns around Gainesville, Alachua County, and tentatively identified as *I. rubicundus* (Bosc.) E. Fischer. Both plants have the same general appearance but a closer examination has revealed consistent differences in them. Long's [4] description, reiterated in Lloyd's notes and Coker's "Gasteromycetes," remarks a red or scarlet pileus. At no stage in the development of the Florida plant is the color of the pileus darker than very pale pink. The disk that closes the perforation at the top is also of the same pale color. The spores of *I. rubicundus* as given by Long are $2 \times 4\ \mu$ while ours are $2–3 \times 4.5–6\ \mu$, a significant difference in size.

The fungus (FIG. 2) is deemed sufficiently different in these characters to be separated as a new species and it is dedicated to Dr. William A. Murrill, who has named so many of the fleshy fungi of Florida and who has collected this species. It is described as follows:

Egg pure white attached to white rhizomorphs. Cup pure white, 2 to 3 cm. high and 1.5 to 2 cm. wide. Stipe curved, fusiform, pink, 10–15 cm. tall and 1.5–2 cm. thick; several chambers thick, each 1–2 mm. wide. Apex closed by a pale-pink disk. Pileus oblique, conical, rugulose, 2–2.5 cm. long and 1.5–2 cm. wide at the loose edge; pale pink under the spore slime. Spores dark olive brown in mass, pale olive green under the microscope, ellipsoid to oblong, smooth, $2–3 \times 4.5–6\ \mu$.

10–15 cm. altus; stipite fusiforme, medio 1½–2 cm. crasso, puniceo sed diluto; volva albo; pileo conico-campanulato circ. 2.5 cm. alto, extus ruguloso; sporis ellipsoideis $4.5–6 \times 2–3\ \mu$. Hab. in pratulo ad Gainesville, Florida.

In sandy soil of centipede grass lawn, Gainesville, Florida. Type collected 26 June 1939 deposited in Herbarium, Fla. Agr. Exp. Station, No. F. *22362*.

COCCOSPORA AURANTIACA Wallr.

One of the common fungous growths met with in moist woods during the fall consists of little ochraceous masses on much decayed wood. At first glance they are usually mistaken for some myxo-

[4] Long, Jour. Myc. 13: 109. 1907.

mycete but their structure is quite different. In fact they may be said to have no structure but consist entirely of a mass of large spores. A collection of typical material was made at Gainesville 22 Jan. 1940 by W. A. Murrill and identified by W. W. Diehl. I can find no report of its occurrence in Florida although it is very common here (F. *22365*).

DACTYLIUM DENDROIDES (Bull.) Fries.

One collection of this hyphomycete has been made in Florida. It was found 16 Jan. 1940 on *Mycena epipterygia* Fries in Planera Hammock, Alachua County, parasitizing a small portion of a large colony of the host. Fungi in the genus *Dactylium* are usually considered imperfect forms of *Hypomyces* sp., but collections of the ascigerous form seldom, if ever, show any signs of the *Dactylium* stage and our collection of *Dactylium* shows no indication of the perfect stage (F. *22355*).

RAMULARIA COLEOSPORII Sacc.

While collecting *Coleosporium Laciniariae* Arthur on various species of *Laciniaria,* it was noticed that a large proportion of the uredia on *Laciniaria elegans* (Walt.) Kze. appeared to be parasitized. A microscopic examination of this material revealed a *Ramularia* referable to *R. Coleosporii* Sacc. The collection was made at Gainesville, Alachua County, on 9 October 1939. This fungus has been reported previously from Puerto Rico on *Coleosporium Ipomoeae* (Schw.) Burrill (F. *22360*).

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AGARICACEAE FROM THE MEDICINE BOW MOUNTAINS OF WYOMING[1]

Florence F. Arenberg[2]

(with 1 figure)

During the summer of 1938 the writer made a collection of the Agaricaceae of the Medicine Bow Mountains of Wyoming at an altitude range of from 8,000 to about 11,000 feet above sea-level. A few more plants were collected in the summer of 1939. Dr. Alexander H. Smith of the University of Michigan gave generously of his time in helping the author to classify her specimens and to determine and describe the new species. Besides the new species which is described below, a list of the Agaricaceae which have not been reported before for Wyoming also follows. The photomicrographs are of slides made from the dried specimens.

1. **Mycena wyomingensis** Smith & Arenberg, sp. nov. (fig. 1)

Pileus 1.5–2.5 cm. broad, convex to somewhat umbonate and siccus, brunneo-atratus; caro cartilaginea, albida, inodora, sapore miti; lamellae confertae vel subdistantes, latae, sinuatae, albidae; stipes 3–5 cm. longus, 2–2.5 mm. crassus, 2–4 cm. radicatus, pallidus, caespitosus, cartilagineus, apice canescens, basi strigosus; superficies pilei e cellusis basidiiformibus unistratosis constans; pleurocystidia 45–60 × 12–20 μ; cheilocystidia 33–48 × 12–20 μ; sporae 6–7.5 × 3.5 μ; basidia tetraspora. Specimen typicum legit prope Univ. of Wyo. Sum. Sci. Camp, June 21, 1938, Arenberg n. 1, in Herb. Univ. of Michigan and Herb. Univ. of Wyoming conservatum.

Pileus 1.5–2.5 cm. broad, convex to some what umbonate and more or less expanded, margin slightly incurved at first, surface hoary when young, appearing rather dry, dark blackish brown over

[1] Excerpt from a Master's Thesis submitted to the Department of Botany and the committee on Graduate Study at the University of Wyoming in partial fulfillment of the requirements for the degree of Master of Science, the citation to which is, Arenberg, Florence, The Agaricaceae of the Medicine Bow Mountains of Wyoming, Master's Thesis, Dept. of Bot. Univ. Wyo. 1939.

[2] Contributions from the Department of Botany and The Rocky Mountain Herbarium of the University of Wyoming, No. *177*.

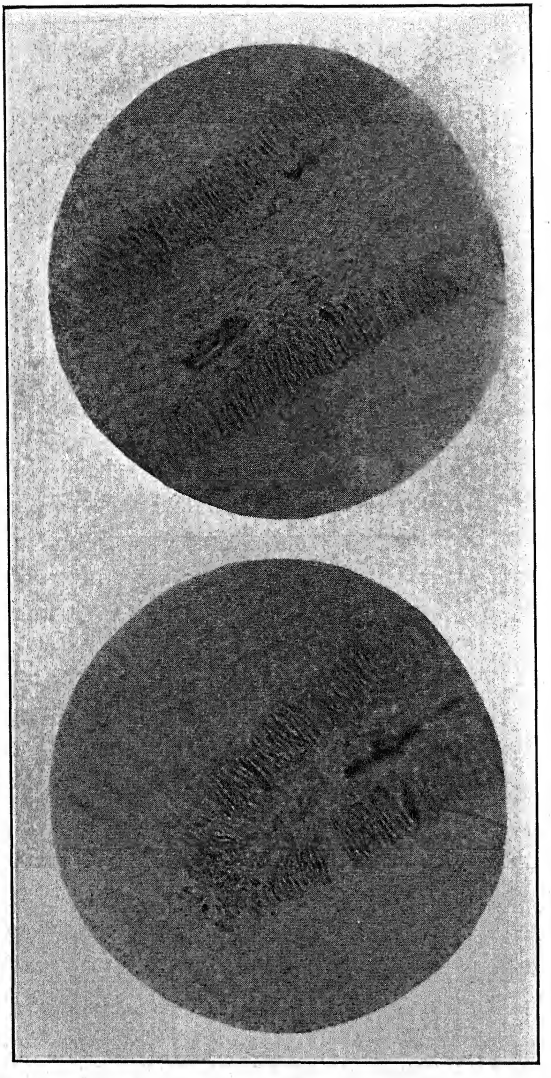


FIG. 1. *Mycena wyomingensis*. Top, section through a gill; below, section through tip of a gill.

all, not fading; flesh rather tough and cartilaginous (but not reviving as in Marasmius), odor slight and not distinctive, taste mild; lamellae, close to subdistant, rather broad, sinuate, in three tiers, whitish, edges even or nearly so, no color change; stipe 3–5 cm. long, 2–2.5 mm. thick, with a pseudorhiza 2–4 cm. long, caespitose,

surface pallid and finely pruinose-pubescent near the apex from numerous caulocystidia, more or less white mycelioid toward the base, pseudorhize mycelioid and with debris clinging to it, very cartilaginous; pileus-trama corticated with a single layer of upright basidia-like cells ($22–35 \times 8–10\ \mu$) with dark smoky brown contents (the cells do not all reach the surface and have pedicels of various lengths but the layer is essentially hymeniform in the arrangement of its elements), hyalin thin-walled cystidia project at intervals from this layer and measure $30–50 \times 7–10\ \mu$; pleurocystidia scattered, ventricose, $45–60 \times 12–20\ \mu$, hyaline, thin-walled, smooth; cheilocystidia similar but shorter and lacking a conspicuous pedicel; spores $6–7.5 \times 3.5\ \mu$, ellipsoid, hyaline, smooth, remaining hyaline in chloral hydrate-iodine solution; basidia four-spored.

Caespitose on rotten wood, under spruce and fir, University of Wyoming Summer Science Camp, alt. 10,000 ft., June 21, 1938, No. 1. This species is very closely related to *Mycena trichoderma* Josserand in Kühner, but differs in the more compact palisade layer over the pileus, the caespitose habit of growth, rooting stipe and smaller spores. The spores do not turn yellow in iodine, and therefore the species is very likely properly classified in the group containing species with amyloid spores. *Mycena lenta* Maire is also rather closely related but is said to be rimose as in certain species of *Inocybe* and to lack pleurocystidia. In addition its colors are apparently more brownish. In Kühner's [3] classification *M. wyomingensis* falls readily in the group *spuriae.*

SPECIES NOT REPORTED BEFORE FOR WYOMING: *Amanitopsis vaginata* Fries var. *livida* Peck; *Armillaria appendiculata* Peck; *Clitocybe maxima* Fries; *Collybia confluens* Fries; *Collybia dryophila* Fries; *Coprinus micaceus* Fries; *Cortinarius armilatus* Fries; *Cortinarius croceofolius* Peck; *Cortinarius decipiens* Fries; *Cortinarius elegantior* Fries; *Cortinarius gentilis* Fries; *Cortinarius pholideus* Fries; *Crepidotus herbarum* Peck; *Inocybe fulvella* Bres. (Robust form Heim); *Inocybe leptophylla* Atk.; *Inocybe radiata* Peck; *Inocybe scabella* Fries; *Lepiota puellaria* (Fries) Rea; *Mycena idiolens* Lundell; *Mycena vitilis* Fries; *Naucoria vernalis* (Peck) Sacc.; *Omphalia gracilis* Quél. (*Mycena immaculata*

[3] Le Genre Mycena, Encyclopéde Mycologique **10**: 1–710. 1938.

Peck); *Pholiota unicolor* (Vahl) Fries; *Russula abietina* Peck; *Russula aurantialutea* Kauff.; *Russula decolorans* Fries; *Russula fragilis* Fries; *Russula puellaris* Fries; *Russula roseipes* Secr.; *Russula tenuceps* Kauff.; *Stropharia distans* (Pers.) Morgan; *Tricholoma arcuatum* (Bull.) Peterson sensu Lange; *Tricholoma brevipes* (Fries ex Bull.) Quél. sensu Lange; *Tricholoma tumidum* Fries.

PSEUDOTRICHIA AND THE NEW GENUS PHRAGMODIAPORTHE [1]

Lewis E. Wehmeyer

(with 11 figures)

In the course of recent studies of the species described under the generic names of *Pseudovalsa* and *Calospora,* a number of species were encountered whose generic positions should be elsewhere. Two such generic segregates are here considered.

Phragmodiaporthe gen. nov.

Perithecia clustered, valsoid, entostromatic areas more or less definitely outlined by a blackened dorsal zone which is continuous between the pustules. Asci clavate, 8- (or 4-?) spored. Spores fusoid-ellipsoid to elongate, four- to many-celled, hyaline or brown. Conidia, where known, elongate-fusoid, one- to four-celled, hyaline, borne in clustered or labyrinthiform, enclosed locules within an entostroma.

Perithecia gregaria ut in genere *Valsa.* Areolae entostromaticae plus minusve evidenter circumvalatae a zona fuscescente marginale inter pustulas continua. Asci clavati (4?) vel 8-spori. Sporae fusiformes vel ellipsoideae vel elongatae cylindracae, multicellulae, hyalinae vel brunneae. Conidia longe fusiformia, 1–4-cellula, vel in entostromatis loculis inclusis pluribus simplicibus vel singulis labyrinthiformibus. Species typica *Phragmodiaporthe Caryae,* in species pluribus generis *Caryae.*

The type species of this genus, *P. Caryae,* has been described several times under a variety of generic names (see synonymy). The stromatic configuration is the same as that found in the genus *Diaporthe* but the ascospores are four- instead of two-celled. Its structure differs from that of *Pseudovalsa* in the lack of any dark colored entostroma, and in the totally different conidial stage. From *Prosthecium,* it differs in the presence of a definite dorsal zone and in the lack of any appendages on the ascospores.

[1] Papers from the Department of Botany of the University of Michigan No. 724.

Both the perithecial and conidial stages of *P. Caryae* suggest a derivation from the genus *Diaporthe*. Certain species of *Diaporthe* show a tendency toward the elongation of the ascospores (*D. megalospora, D. tiliacea* and others). The writer has described varieties of both *D. Fagi* (**4**, p. 146) and *D. strumella* (**5**, p. 46) in which such an elongation of the ascospores has taken place. *Calospora Ribis* Gutner was described as having four-celled ascospores. Material kindly sent the writer by Dr. Naumov, however, contained spores which were 6- to 8-guttulate but only two-celled and which proved to be exceptionally long spores of the var. *longispora* of *Diaporthe strumella.* If the spores of such a fungus became three-septate, which is not at all unlikely, it would fall in the genus *Phragmodiaporthe.*

The conidial stages found associated with the perithecia on the type material of *Cryptospora Caryae* Peck and *Pseudovalsa Fairmani* Ellis & Ev. are also easily derived from a *Phomopsis* (or *Fusicoccum*) type. The labyrinthiform locules formed within a light colored entostroma are characteristic of these form genera. The conidia differ from those of *Phomopsis* in the elongate-fusoid shape and the tendency to be four-celled. Certain species of *Diaporthe* show this elongation (*D. leiphaemia*) and tendency to septation (*D. tiliacea*) of the conidia.

Phragmodiaporthe aculeata, the second species, is not so obviously related to *Diaporthe* as is *D. Caryae. P. aculeata* has a dark colored entostroma with large irregular perithecial cavities which have rather indefinite walls and in this respect resemble a dothideaceous type of organization. The material examined was immature and showed four-spored asci. The spores were one-celled and hyaline, although Petch describes the spores as seven- to eleven-septate and brown at maturity. Additional and more mature material of this species may show it to have other affiliations.

Phragmodiaporthe Caryae (Peck) comb. nov. (FIGS. 1–4)

Cryptospora Caryae Peck, Ann. Rep. N. Y. State Mus. **38**: 106. 1885.

Pseudovalsa Fairmani Ellis & Ev. Proc. Roch. Acad. 1890: 51.

Winterella Caryae (Peck) Kuntze, Rev. Gen. 34. 1891.

Valsa apatela Ellis & Holway, Bull. Lab. Nat. Hist. Univ. Iowa 3: 42. 1895.

Aglaospora Fairmani (Ellis & Ev.) Kuntze, Rev. Gen. 3^3: 441. 1898.

Calospora apatela (Ellis & Holway) Sacc. & Sydow, In Sacc. Syll. Fung. **14**: 593. 1899.

Appearing on the surface as conic pustulate swellings, 0.5–2 mm. in diameter, with a central cluster of stout-papillate erumpent ostioles or, where the periderm is torn away, appearing as circular blackened discs. No ectostroma formed beyond the blackening of the bark surface about the ostioles. This marginal blackening dips sharply into the bark as a lateral zone which may continue along the wood surface between the pustulate entostromatic areas. Perithecia spheric to irregular from crowding, 300–600 × 200–500 μ, clustered in the entostromatic areas, bounded by the marginal zone. Asci clavate, 85–150 × 19–21 μ. Spores biseriate, long-fusoid, straight or slightly curved, hyaline, four-celled, slightly or distinctly constricted at the septa, 27–44 × 5–7.5 μ.

HOSTS: *Carya* spp.

DISTRIBUTION: Iowa, New York.

COLLECTIONS: (*Cryptospora Caryae*) N. Y. St. Mus., Knowersville, N. Y., May, 1884, C. H. Peck (type).

(*Pseudovalsa Fairmani*) Ev. Herb., Lyndonville, N. Y., May, 1890, C. E. Fairman (type).

(*Valsa apatela*) Herb. Iowa St. Coll., ex Holway Herb., Decorah, Iowa, March, 1884 (type).

The blackened marginal zones of this species and its four-celled, fusoid spores without appendages set it aside from the other species of *Calospora* and *Pseudovalsa*.

An associated conidial stage is found on the types of *Pseudovalsa Fairmani* and *Cryptospora Caryae*. It consists of labyrinthiform to confluent, irregular, pycnidial cavities formed within a light colored entostromatic area of the upper bark, which is irregularly bounded by a dorsal zone which dips into the bark. The conidia borne in these enclosed chambers are elongate, fusoid-clavate to oblong-cylindric, straight or somewhat curved, one-celled, hyaline, or often 2- to 4-celled. There are no constrictions at the septa and the conidia measure 35–43 × 3.5–5.5 μ.

Phragmodiaporthe aculeata (Petch) comb. nov. (FIGS. 5–7)

Aglaospora aculeata Petch, Ann. Bot. Gard. Peradeniya **3**: 3. 1906.

Appearing on the surface as strongly pustulate, hemispheric or conic swellings, 1–3 mm. in diameter, with a closely adherent periderm and a central carbonaceous disc consisting of a fascicle of two to five very stout (0.5–0.8 mm. in diam.), somewhat elongate, cylindric ostioles, mostly broken away, leaving a hollow cylindric stub. Perithecia appearing as irregular to flattened, much elongated cavities, 500–2000 × 500 μ, imbedded in a black stroma of pseudoparenchyma and with very slightly differentiated walls. Entostromatic area outlined by a definite, broad, black, dorsal zone dipping into the bark between the perithecial clusters. Asci clavate, mostly four-spored, 110–130 × 22–28 μ. Spores lying parallel in the ascus, long-fusoid-cylindric, slightly curved, one-celled, hyaline, granular, 88–95 × 9–11 μ. Petch gives the spores as finally brown and seven- to eleven-septate and 90–105 × 12–15 μ.

HOST: Thea.

DISTRIBUTION: Ceylon.

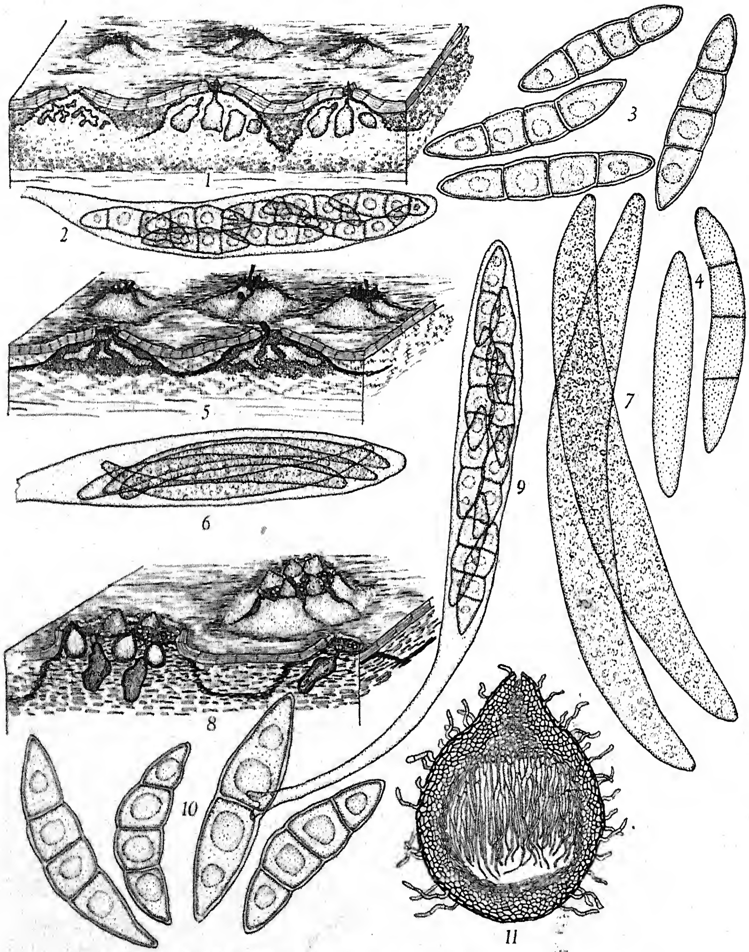
COLLECTIONS: Kew, Petch, No. *6456,* Dec. 1921.

The long fusoid spores which are at first hyaline and the dorsal blackened zones of this species suggest relationships with *P. Caryae.* The irregular perithecia with faintly developed walls and the dark colored parenchymatic surrounding stroma, however, are not entirely in accord with the writer's concept of this genus.

PSEUDOTRICHIA Kirschstein.

The nomenclatorial history of this genus is somewhat involved. In 1912, in his Fl. Boh. & Mor. No. *132,* Petrak issued a fungus under the name of *Calospora ambigua* Pass. with the notation "Forsan nova species." In 1921 (2, p. 284), he erected a new genus, *Khekia,* with a description of the fungus in this exsiccata, gave *Khekia ambigua* (Pass.) Petr. as the type species and *Calospora ambigua* Pass. as a synonym of the type species. The writer has not seen the type of Passerini's *C. ambigua,* but Passerini states that his fungus approaches *Sphaeria arcuata* Currey, differing only in the broader (7–8 μ) and colorless spores. He gives the host as *Quercus.* Currey's *Sphaeria arcuata* is *Pseudo-*

valsa longipes, the ascospores of which are often hyaline and reach a diameter of 7–8 μ. *Calospora ambigua* is undoubtedly the same as *Pseudovalsa longipes* and as it is cited as a synonym of the type



FIGS. 1–4, *Phragmodiaporthe Caryae*; 5–7, *P. aculeata*; 8–11, *Pseudotrichia aurata*.

species of *Khekia*, this genus name becomes a synonym of *Pseudovalsa*.

In 1939, Kirschstein (1, p. 125), again used Petrak's Fl. Boh. & Mor. No. *132* (which he erroneously cited as No. *123*) as the

basis of a new genus, *Pseudotrichia,* which name, therefore, becomes available for the genus based on this collection.

Petrak's fungus, which occurs on the stromata of a *Diatrypella,* is, furthermore, the same as *Thyridaria aurata* Rehm (3, p. 392). The type of *T. aurata* is upon moldy wood from Austria and the perithecia are scattered singly or clustered superficially, showing only slight traces of any felty subiculum in a few spots. A later collection from Dearness, on old sphaeriaceous stromata on *Crataegus,* was given by Rehm (in Herb.) as a var. *stromatica* of this species. The perithecia of this specimen are clustered on the old sphaeriaceous stromata.

Petrak, in his discussion of the genus *Khekia,* states that it is a parasite upon *Diatrypella* stromata, and that Rehm (who identified his material) probably mistook the *Diatrypella* stromata for that of a *Calospora.* Petrak gives a very good description of the fungus but says that the ostioles are flattened, which is not true of the material seen by the writer. As a result of this flattening of the ostioles, he places the genus as a stromatic form of the Lophiostomataceae.

Kirschstein, in his discussion of *Pseudotrichia,* correctly states that no true stroma is present and that the ostiole is conic. He places his genus in the Trichosphaeriaceae because of the tomentose character of the perithecium.

In 1938, the writer collected material of this same fungus on stromata of an *Eutypella* on *Ulmus americana,* near Ann Arbor, Michigan. All of the variations mentioned above were found on this collection, and there is no doubt in the writer's mind that they all represent a single species which grows normally on the stromata of various pyrenomycetes but may occur on bark or decorticated wood which has been infected by these same fungi. The perithecia may originate on or beneath the surface of the substratum and may be scattered, but are usually clustered on the stromata upon which they grow. The young perithecia are pyriform with a comparatively long beak, but as they increase in size they become globose and the ostiole is less conspicuous. The young perithecia are covered with a bright yellow-green tomentum composed of hyphae which grow out from the wall cells. As the fruit bodies mature, these hyphae become darker brown, giving a brown color

to the perithecia, or they may grow out as a sparse mycelial subiculum. The ostiolar portion of the perithecium retains the yellow-green coloration longest. A complete description follows:

Pseudotrichia aurata (Rehm) comb. nov. (FIGS. 8–11)

Thyridaria aurata Rehm, Ann. Myc. **10**: 392 (also **12**: 172). 1912.

Pseudotrichia stromatophila Kirschst. Ann. Myc. **37**: 125. 1939.

Usually found growing on old decaying pyrenomycetous stromata, or on bark or decorticated wood infected by these fungi. Perithecia pyriform then globose, 300–700 μ in diameter, scattered singly, botryose clustered on the host stromata, or in small confluent groups, at first covered with a bright yellow-green tomentum which becomes rubbed off or becomes dull brown or black. Ostiole conic to papillate. Perithecial wall thick, consisting of an inner layer of brown walled parenchyma cells and an outer layer of interwoven dark brown hyphae bearing the tomentum. Perithecia sometimes surrounded by a felty growth of coarse thick-walled brown hyphae. Asci elongate-clavate, with a tapered basal stalk and a slightly thickened apical wall, 100–160 $\times$ 14–18 μ. Spores biseriate above, irregular below, fusoid, straight to curved, hyaline, two-celled at first, becoming four-celled, constricted at the septa, with a large guttula in each cell, rarely pale brown at maturity, 29–41 $\times$ 5–9 μ. Paraphyses numerous, filiform, hyaline, persistent.

HOSTS: Pyrenomycetous stromata on *Crataegus* and *Ulmus*.

DISTRIBUTION: Austria, Czechoslovakia, Michigan, Ontario.

EXSICCATI: (*Calospora ambigua*) Petr., Fl. Boh. & Mor. *132* (type). (*Thyridaria aurata*) Rehm, Asc. *2111*.

COLLECTIONS: (*Thyridaria aurata*) Riksm., ex. Rehm Herb., Ybbsitz, Austria, leg. Lambert (type); London, Ont., June 1911, Dearness, *3321* (var. *stromatica*).

(*Pseudotrichia aurata*) W. Herb., No. *3881*.

Ascospores from the collection of *Pseudotrichia aurata* on *Ulmus americana* were sprayed onto nutrient agar on December 7, 1938. Germination occurred within twenty-four hours by the formation of one or two germ tubes, 5.5 μ in diameter, from the ends of the

spores. Some of the spores turned pale brown before germination, whereas others remained hyaline. Rehm states that the spores of his *Thyridaria aurata* turn brown at full maturity.

On oat agar, a limited colony growth, grayish to brown or black, was formed and, after a week or two, numerous gray-black stromata appeared and soon showed the superficial yellow-green furfurescence characteristic of this species.

Some of the original collection of *Ulmus* twigs, which showed healthy *Eutypella* stromata, but no signs of *Pseudotrichia,* were autoclaved and inoculated. Healthy twigs of *Ulmus,* with no *Eutypella* present, were also autoclaved and inoculated. Growth, and the formation of stromata, took place in both instances. On the *Eutypella* stromata, the typical clusters of yellow-green stromata appeared. On the *Ulmus* twigs not bearing *Eutypella* stromata, the *Pseudotrichia* stromata arose beneath the periderm but were soon strongly erumpent. In this situation, there was often a slight basal stromatic development beneath the periderm. None of the stromata, on either agar or twigs, ever matured to the stage of developing spores, but the course of their development indicated that they were perithecia. No conidial fructifications were seen.

The stromata (perithecia?) of *Pseudotrichia* originated as an intertwined mass of vegetative mycelium which proliferated to form a spheric to ellipsoid primordium. The outer cell walls of this primordium (FIG. 11) form a wall-like layer of rather large, brown-walled pseudoparenchyma, from which grow out the hyphal elements forming the yellow-green tomentum. The inner core of the primordium remains a mass of intertwined hyphae. At a somewhat later stage, the initiation of the ostiole and the central cavity occurs. The cells in a limited area, just beneath the upper wall of the perithecium, enlarge, appear parenchymatic, become meristematic and cause the conic beak-like extension of the perithecium (FIG. 11). Just beneath this area of ostiole initiation, the cells of another lens-shaped area of meristematic hyphae begin to thicken and elongate downward, forming an active palisade-like area in the center of the perithecium (FIG. 11). The increase in the size of the whole primordium at this same time, causes a draw-

ing away of the lower portion from the free ends of this palisade, so that the ends of these hyphae lie free as the branching tips of these downward growing paraphyses. No differentiated sex organs, ascogonia or ascus primordia were seen in these stromata in culture, but the asci probably arise from an area of prosenchymatous hyphae lying parallel to the periphery of the lower portion of the central cavity and grow upwards into the paraphyses above. This development suggests, but does not entirely agree with, that found in the Pseudosphaeriales. The stromatic primordia, if formed in close proximity, may become confluent or, very often, may form two to three central fertile areas within one stroma.

The use of the sphaeriaceous, pseudosphaeriaceous and dothideaceous types of organization for the rearrangement of genera would necessitate an entire revision of the Sphaeriales. These types of organization are based upon perithecial development, and there are no doubt many minor variations and intergradations in the ontogeny of various genera and species. Our present knowledge is extremely fragmentary, the distinctions between these types of development are still vague, and judgments from mature material are very uncertain. No general revision can yet be made on these bases.

The genus *Pseudotrichia* represents a type of organization found in some species of *Didymella* which grade off into the genus *Massarinula,* which, in turn, by further septation of the asocspores, grades off into certain species of *Massarina.* These species are often associated with decayed wood or pyrenomycetous stromata. *Diaporthe microstroma* Ellis & Ev. and *Myrmaecium* (*Diaporthe*) *subaquila* (Berk. & Curt.) Ellis & Ev. belong to this group.

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EXPLANATION OF FIGURES

FIGS. 1–4, *Phragmodiaporthe Caryae* (Peck) Wehm.: 1, radial section through stromata; 2, ascus; 3, ascospores; 4, conidia, as found associated on type. 5–7, *Phragmodiaporthe aculeata* (Petch) Wehm.: 5, radial section through stromata; 6, ascus; 7, ascospores, as seen on specimen examined. 8–11, *Pseudotrichia aurata* (Rehm) Wehm.: 8, radial section through old stromata of *Eutypella* bearing perithecia of *P. aurata;* 9, ascus; 10, ascospores; 11, vertical section of perithecium, showing latest stage of development occurring in culture and illustrating the ostiolar meristem and downward growth of paraphyses in the central cavity.

UREDINALES OF NEW GUINEA—II[1]

George B. Cummins[2]

(with 5 figures)

The 15 species of Uredinales reported in this paper were collected by Mrs. Mary Strong Clemens in Morobe District, New Guinea. The type specimens are deposited in the Arthur Herbarium of the Department of Botany, Purdue University Agricultural Experiment Station.

Puccinia hennopsiana Doidge.

On *Mariscus* sp., Wantoat, Jan. 27, 1940 (*11046*).

The teliospores of this collection are shorter (10–16(–18) × (30–)40–60 μ) than those described for *P. hennopsiana* (15–20 × 40–80 μ), but the loculate sori and the color and shape of the spores are the same. No differences are detectable in the uredia.

Puccinia Romagnoliana Maire & Sacc.

On *Cyperus difformis* L. f., Kajabit Mission, Sept. 5, 1939 (*10655*), Oct. 29, 1939 (*s.n.*).

Puccinia exoptata sp. nov. (fig. 1)

Uredia culmicola subepidermalia, sparsa, elongata, usque 2 mm. longa, cinnamomeo-brunnea; urediosporae globoideae, ellipsoideae vel obovoideae, 14–18 × 18–23 μ; membrana 1–1.5 μ cr., flavida vel cinnamomeo-brunnea, minuteque echinulata; poris germ. 2, aequatorialibus. Teliosporae in uredia oblongo-ellipsoideae vel clavatae, ad septum constrictae, 14–17 × 30–48 μ; membrana pallide castaneo- vel aureo-brunnea, 1.5 μ cr., ad apicem 3–6 μ, levi; pedicello hyalino, brevi.

[1] Contribution from the Department of Botany, Purdue University Agricultural Experiment Station, Lafayette, Indiana.

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[2] I am indebted to Doctors F. J. Hermann and H. K. Svenson for giving opinions concerning the identity of some of the hosts.

On *Eleocharis laxiflora* (Thwaites) H. Pfeiff., Boana, June 16, 1938 (*8291*).

PUCCINIA FIMBRISTYLIDIS Arth.

On *Fimbristylis annua* (All.) R. & S., Sattelberg, Feb. 27, 1936 (*1906*), Feb. 29, 1936 (*s.n.*); Ogao, June 20, 1939 (*s.n.*), June 26, 1939 (*s.n.*); Kajabit Mission, July 24, 1939 (*10473*); Yukwak, Jan. 5, 1940 (*10947B*).

PUCCINIA SCIRPI-GROSSI Sydow.

On *Scirpus grossus* L. f., Kajabit Mission, Aug. 31, 1939 (*10641bis*).

PUCCINIA SCLERIAE (Pazschke) Arth.

On *Scleria hebecarpa* Nees, Malalo Mission, Salamaua, Aug. 26, 1935 (*22*); Boana, June 18, 1938 (*s.n.*); Kajabit Mission, July 24, 1939 (*10470*), Sept. 25, 1939 (*s.n.*); Wantoat, Jan. 10, 1940 (*10953*). On *Scleria* sp. Wantoat, Jan. 10, 1940 (*10954*).

Puccinia papuana sp. nov. (FIG. 2)

Urediis hypophyllis, sparsis, ovoideis, 0.3–0.7 mm. longis, pallide cinnamomeo-brunneis; urediosporae late ellipsoideae vel obovoideae, 17–23 × 24–30 μ; membrana 1.5 μ cr., pallide cinnamomeo-brunnea, moderate echinulata; poris germ. 3 vel plerumque 4, aequatorialibus. Teliis hypophyllis, sparsis, rotundatis vel ovoideis, 0.3–0.6 mm. longis, pulvinatis, atro-brunneis; teliosporae oblongo-clavatae vel oblongo-ellipsoideae, utrinque rotundatae vel ad basim attenuatae, medio constrictae, 18–20 × 32–40 μ; membrana 1.5–2 μ cr., ad apicem 8–11 μ, castaneo-brunnea, levi; pedicello hyalino, persistenti, sporam aequante.

On *Scleria* sp., Yukwak, Jan. 5–6, 1940 (*10963*).

Puccinia papuana is similar to *P. xanthopoda* Sydow, but has shorter, broader teliospores with hyaline pedicels.

Puccinia Oreoboli sp. nov. (FIG. 4)

Urediis amphigenis, ovoideis, 0.2–0.7 mm. longis, brunneis; urediosporae obovoideae vel late ellipsoideae, 18–26 × 25–32 μ; membrana flavida vel cinnamomeo-brunnea, moderate echinulata, 2.5–3 μ cr.; poris germ. 2, aequatorialibus. Teliosporae in uredia clavatae, ad apicem rotundatae, ad basim

attenuatae, medio leniter constrictae, 16–20 × 39–52(–59) μ; membrana 1.5 μ cr., ad apicem 4–10 μ, aureo-brunnea, levi; pedicello flavo, sporam breviore.

On *Oreobolus* sp., vicinity of Samanzing, Feb. 15, 1939 (*9608*, type), Feb. 17, 1939 (*s.n.*).

Puccinia conquisita sp. nov. (FIG. 3)

Amphisoris hypophyllis, sparsis, rotundatis, 0.2–0.5 mm. diam., obscure cinnamomeis; amphisporae obovoideae, 18–24 × 25–33 μ; membrana aureo- vel castaneo-brunnea, 1.5–2 μ cr., ad apicem 4–10 μ, moderate echinulata; poris germ. 4 (3–5), aequatorialibus. Teliis urediis conformibus; teliosporae

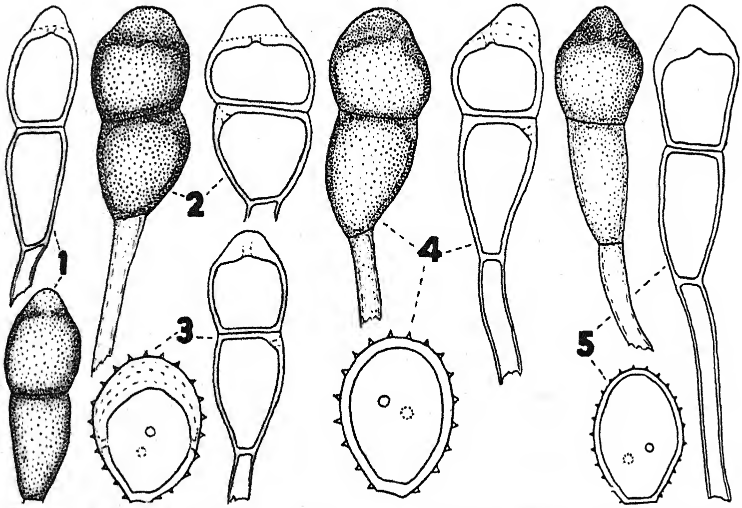

FIG. 1. *Puccinia exoptata;* 2, *P. papuana;* 3, *P. conquisita;* 4, *P. Oreoboli;* 5, *P. indotata.*

clavatae, ad apicem rotundatae vel leniter attenuatae, ad basim attenuatae, medio constrictae, 14–18 × 34–50 μ; membrana pallide castaneo- vel aureo-brunnea, 1–1.5 μ cr., ad apicem 4–8 μ levi; pedicello hyalino, sporam aequante vel breviore, fragili. Statim germ.

On *Carex sarawaketensis* Kukenth., vicinity Samanzing, Dec. 7–21, 1939 (*10367*).

PUCCINIA EXTENSICOLA Plowr.

On *Carex* aff. *secta* Boott, vicinity Samanzing, Dec. 1938–Jan. 1939 (*9448*), Feb. 10, 1939 (*9566bis*).

Puccinia indotata sp. nov. (FIG. 5)

Urediis hypophyllis, sparsis, oblongis, 0.2–0.6 mm. longis, cinnamomeis; urediosporae ovoideae vel ellipsoideae, 15–19 × 20–27 μ; membrana 1.5 μ cr., pallide cinnamomeo-brunnea vel flavida, moderate echinulata; poris germ. 2, plus minusve subequatorialibus. Teliis urediis conformibus sed atro-brunneis et usque ad 1.0 mm. longis, teliosporae oblongo-clavatae vel clavatae, ad apicem plerumque rotundatae, medio leniter constrictae, 13–18 × (37–) 43–55 μ; membrana 1.5 μ cr., aureo-brunnea vel flavida, ad apicem 5–9 μ cr. et castaneo-brunnea, levi; pedicello persistenti, sporam aequante vel breviore, hyalino.

On *Carex indica* L., Yunzaing, Aug. 26, 1936 (*4003a*). On *Carex* sp., Samanzing, June 28, 1939 (*10380bis,* type); Wantoat, Jan. 10, 1940 (*10952X*), Jan. 15, 1940 (*11005bis*).

Puccinia indotata is near to *P. Lyngbyei* Miura but has smaller urediospores and paler teliospores with hyaline pedicels.

UREDO KYLLINGIAE P. Henn.

On *Kyllinga intermedia* R. Br., vicinity Samanzing, Dec. 19, 1938 (*s.n.*).

Uredo dapsilis sp. nov.

Uredia amphigena, subepidermalia, sparsa, ovoidea, 0.5–1.5 mm. longa, flavo-brunnea, diu epidermide tecta; urediosporae ellipsoideae, oblongo-ellipsoideae vel obovoideae, 18–25 × 29–44 μ; membrana flavida vel pallide cinnamomea, 2–3 μ cr., moderate echinulata; poris germ. (4–) 5–6 (–7), plus minusve aequatorialibus.

On *Cyperus* aff. *cephalotes* Vahl, vicinity Samanzing, Dec. 1938–Jan. 1939 (*9449*).

Uredo subsolana sp. nov.

Uredia hypophylla, subepidermalia, sparsa, ovoidea, 0.2–0.4 mm. longa, cinnamomea; urediosporae ovoideae vel oblongo-ellipsoideae, 13–16 × 19–29 μ; membrana 1–1.5 μ cr., cinnamomeo-brunnea vel flavida, minuteque echinulata; poris germ. 2, aequatorialibus vel plus minusve subaequatorialibus.

On *Scleria* sp. Malalo Mission, Salamaua, May 27, 1936 (*3146*).

This rust is similar to the uredia of *Puccinia Scleriae* but the urediospores are narrower and have only two pores.

Uredo unciniicola sp. nov.

Uredia hypophylla, sparsa, flavida, ovoidea, 0.2–0.5 mm. longa, subepidermalia, diu epidermide tecta; urediosporae late ellipsoideae, ellipsoideae vel obovoideae, 16–23 × 22–27 μ; membrana 1 μ cr., pallide flavida, minuteque echinulata; poris germ. obscuris, verisimiliter aequatorialibus.

On *Uncinia caespitosa* Boott, vicinity Samanzing, Jan. 3, 1939 (*9440*).

Uredo unciniicola differs from *Puccinia Unciniarum* Diet. & Neger in having smaller urediospores with a thinner and more nearly hyaline wall.

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HOST RELATIONS IN SPECIES OF DIPLODIA AND SIMILAR GENERA

NEIL E. STEVENS

A number of fungi recently sent for study by H. S. Fawcett included 29 specimens of what the writer regards as *Diplodia sarmentorum* Fries. These specimens were on various species of citrus and came from Brazil, Sicily and California. Study of this material led to a reëxamination of all the slides of this fungus in the herbarium of the Bureau of Plant Industry, including the type and authentic specimens cited in the synonomy,[1] and to reading some recent literature, including those parts of Grove's [2] second volume, which deal with this and the closely related fungi which I have studied. Grove's concept of the host relations of these fungi is almost diametrically opposite to mine. Since this question must enter into almost every determination of a specimen it may be worthwhile to restate the evidence on which my opinion is based, regretting that in one of the various earlier papers on this group I have not more fully and more coherently presented this evidence and especially that I can no longer discuss this personally with the gracious and distinguished author of the volumes which in his own words "set before the English speakig reader, for the first time in his own language, and so far as it is illustrated by the British species of the group, a panoramic view of the skilful structure erected by the inimitable genius of Saccardo, some fifty years ago, to include them all in one scheme."

Grove's conclusion, as stated in his opening discussion (p. 32) of the genus, is: "The majority of the species of *Diplodia* and *Botryodiplodia* are extremely similar to one another, especially in

[1] Stevens, N. E. Two species of Physalospora in England. Mycologia **28**: 330–336. 1936.

[2] Grove, W. B. British stem and leaf fungi, Vol. II, 1937 (pp. 17, 32, 54, 406).

regard to the spores. They can be discriminated only by the host-plant." However, he lists the species of *Diplodia* on different hosts under different names and the "species are arranged in the simple alphabetical order of the host-genera." Nearly 20 years ago when we had been studying these fungi for some years, Dr. C. L. Shear and I held exactly this opinion and the evidence which forced us to abandon it is as follows:

We were then studying, and have been collecting and studying at intervals ever since, the Pyrenomycetes usually referred to the genera *Botryosphaeria* and *Physalospora.* These fungi appear to be closely related and probably really constitute a single genus. Of course, we included the pycnidial forms known to belong to these ascogenous stages and a number of other pycnidial forms which might reasonably be considered as being closely related.

While there are in this group a number of fungi known to be parasitic on various hosts, and some of them are important causes of fruit rots, they are most easily and abundantly found on branches of trees which have been cut while still healthy and permitted to lie on the ground for several months. Roadsides and telephone lines through deciduous woodlands make ideal collecting grounds. In such a situation the number of hosts for *Diplodia* spp. that can be recorded is limited only by the hosts available and the patience of the collector.

Included among these fungi, indeed serving as a point of departure in my studies was one, *Botryosphaeria Ribis chromogena* G. & D., which while it was known to fruit abundantly on dead stems of cultivated currants and to grow readily on various culture media, had long been known to be a serious parasite of currants. In addition it was further distinguished from similar fungi by the characteristic pink color produced in cultures on corn meal.

In 1921 almost by accident I collected on fruits of horse chestnut (*Aesculus Hippocastanum*) a fungus morphologically identical with *B. Ribis chromogena* which showed the same cultural characters and on innoculation proved capable of killing branches and canes of vigorous currant bushes. In 1922 Miss Anna Jenkins found on cultivated rose bushes a fungus with all the morphological and physiological characters of *B. Ribis chromogena,* including its

ability to kill currant canes. Our results were published jointly in 1924. Subsequent collecting in the southeastern states led to the discovery on 15 species of woody hosts of a fungus which showed all the characters of *B. Ribis chromogena,* including parasitism on currants.

Now, whatever may be one's prejudices in favor of the idea that fungi on different hosts are more conveniently regarded as separate species, when there are collected from several unrelated hosts individual specimens which are morphologically indistinguishable, show similar distinctive cultural characters, and on inoculation prove to be seriously parasitic on plants of a single clone, the conclusion would seem to be inevitable that these individual fungus plants all belong to the same species. Of course, the bearing of this on the *Diplodia* problem is that it seems to create a presumption that species closely related to *B. Ribis chromogena* and with similar growth habits on some hosts might have somewhat similar host ranges.

Further evidence as to the host range of this particular fungus came from a wholly unexpected source, one which seemed to us to have a direct bearing on the host relations of other fungi causing rots of apples. In the course of an extensive study of the temperature relations of " black rot " of apples, Miss E. A. Fenner made during 1923–1924 a large number of isolations from diseased tissues of what was supposed to be the typical black rot organism *S. malorum* Peck. When the cultures were allowed to fruit, however, a considerable portion, over 10 per cent of those made in 1923, and 15 per cent of those made in 1924, were found to be *B. Ribis,* and of these several were *B. Ribis chromogena,* as indicated by all tests, including the killing of currant canes after inoculations which I made for Miss Fenner.

The importance of this discovery in relation to the probable host ranges of the apple black rot fungi recognized earlier seemed to us considerable. Here was a fungus, *B. Ribis chromogena,* which by all tests proved capable of causing a decay of apples and pears, which had growth habits indistinguishable from *S. malorum* Peck (though with different pycnospores), but which already had been described as a parasite on currants. Obviously, it could not be

given several specific names or even two. This particular fungus might well have been found first on apples and thus have borne the specific name "*malorum*" instead of "*Ribis*." Would its host range then have been altered? The same series of observations seemed to bear on the question of host relations from another angle. There is always a tendency to consider as identical similar fungi on the same host. Yet we were here isolating fungi causing decay of the fruit of a single variety, yet producing pycnospores so different that there would be no possibility of considering them as belonging to the same species.

Nearly ten years later C. O. Smith,[3] by a series of inoculations on over 50 species of plants, distributed among 39 genera and 20 families, obtained additional evidence of the wide range of host plants on which this fungus will grow.

Grove (p. 54) refers to the fact that T. Petch holds a "similar thesis about the tropical *Botryodiplodia Theobromae*." So do many others who have studied this fungus in the field. In 1926 and earlier when we were working out the life history of what we called *Physalospora rhodina* (Berk. & Curt.) Cooke, we had in culture for comparison isolations of species of *Diplodia* received from correspondents in different parts of the world on various tropical hosts. Not only were the pycnospores (the only spores we could produce in culture) identical but the cultures showed the unusual characteristic of growing at 37° C., and turned potato dextrose agar pink at that temperature. We had found several years earlier that the similar fungi isolated from a number of hosts would produce the "end rot" in citrus fruits characteristic of "*Diplodia natalensis*."

The conclusion that these were in fact merely separate isolations of a single species seems to us inescapable, and we accordingly reduced *P. gossypina* to synonymy. Though I have not as yet undertaken the task of preparing a complete synonymy of this fungus, it would undoubtedly include "*Botryodiplodia Theobromae*."

Admittedly each fungus is a special case and each may behave

[3] Smith, C. O. Inoculations showing the wide host range of *Botryosphaeria Ribis*. Jour. Agr. Res. 49: 467–476. 1934.

differently from any other, but such observations as these here reviewed seem to me to suggest that it is much more probable that such fungi growing on dead or weakened plant parts, and which grow readily on a wide variety of culture media, have a wide host range, than that a distinct fungus species grows on each host species.

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GEORGIA PYRENOMYCETES. II

JULIAN H. MILLER

A critical revision of most of the species in the Pyrenomycetes has not been attempted since Ellis and Everhart (2) in 1892, and so the present status of many Georgia fungi is not in conformity with modern usage. In this paper the writer changes the position of several, and reduces some names to synonomy, in order to clear nomenclatural tangles in a check list of Georgia Ascomycetes.

1. **Hypoxylon grandineum** (Berk. & Rav.) comb. nov.

Diatrype grandinea Berk. & Rav. Grevillea **4**: 95. 1876.
Anthostoma grandineum Sacc. Syll. Fung. **1**: 299. 1882.
Fuckelia grandinia Cooke, Grevillea **12**: 53. 1883.
Camarops grandinea Cooke, Grevillea **13**: 108. 1884.

This fungus consists of a flat, irregular thin black stroma, with projecting perithecia, growing over rough bark of oak. The ascospores are brown and elliptical, typical of the Xylariaceae. The position in *Anthostoma,* as in Ellis & Everhart (l. c.), is untenable as the concept of the latter consists of perithecia pustulate or effused, sunken in the matrix within a valsoid or eutypoid stroma; and a superficial or erumpent stroma entirely of fungous tissue as in the above fungus falls within *Hypoxylon.*

On *Quercus* sp., Clarke and Rabun Counties.

The genus *Nummularia* was described by Tulasne (6), and included both *N. Bulliardi* Tul. and *N. discreta* (Schw.) Tul., two species of widely differing characters. The writer (3) attempted to correct this by proposing the latter with its concave disc and sunken perithecia for the type, and that *N. Bulliardi,* with peripheral perithecia, be returned to *Hypoxylon.* This step seems logical, because in the writer's concept of *Hypoxylon* most of the species are as smooth and flat as *N. Bulliardi* under one environmental condition and pulvinate or even semiglobose under another,

but none of them have sunken perithecia as in *N. discreta.* In order to clarify Georgia forms, the following species, formerly in *Nummularia,* are transferred to *Hypoxylon.*

2. **Hypoxylon hypophlaeum** (Berk. & Rav.) comb. nov.

Diatrype hypophlaea Berk. & Rav. Grevillea **4**: 95. 1876.
Anthostoma hypophlaeum Sacc. Syll. Fung. **1**: 306. 1882.
Nummularia hypophlaea Cooke, Grevillea **12**: 7. 1883.

On *Alnus rugosa* (DuRoi) Spreng., Thomas Co.; *Carpinus caroliniana* Walt., Clark, Jackson Counties; *Cercis canadensis* L., *Fraxinus pennsylvanica* Marsh. v. *lanceolata* (Borkh.) Sarg., *Liriodendron Tulipifera* L., Clarke Co.; *Magnolia virginiana* L., Bullock Co.; *Ostrya virginiana* (Mill.) K. Koch, *Quercus sp., Vitis Labrusca* L., Clarke Co.

3. **Hypoxylon maculum** (Schw. ex Cooke) comb. nov.

Sphaeria macula Schw. Schr. Nat. Ges. Leipzig **1**: 31. 1822.
Nummularia macula Cooke, Grevillea **12**: 6. 1883.
On *Quercus nigra* L., Clarke and Thomas Counties.

4. **Hypoxylon mediterraneum** (DeNot.) comb. nov.

? *Sphaeria Clypeus* Schw. Schr. Nat. Ges. Leipzig **1**: 31. 1822.
Sphaeria mediterranea DeNot. Microm. Ital. Dec. 6, no. 2. 1851.
Hypoxylon regium DeNot. Sphaer. Ital. Cent. 1, Fasc. 1. no. 12. 1863.
Hypoxylon repandoides Fuckel, Jahrb. Nass. Ver. Nat. **23**: 236. 1870.
Diatrype Clypeus Berk. Grevillea **4**: 95. 1876. Non Schw.
Nummularia repandoides Sacc. Syll. Fung. **1**: 397. 1882.
Nummularia australis Cooke, Grevillea **11**: 148. 1883.
Nummularia Clypeus Cooke, Grevillea **12**: 6. 1883. Non Schw.
Nummularia mediterranea Sacc. Syll. Fung. **1**: 400. 1882.
Nummularia regia Sacc. Syll. Fung. **1**: 400. 1882.

This species is cosmopolitan in distribution and is very common in the eastern and southern United States. It is represented in

the writer's herbarium from almost every state. In most American herbaria it is named either *N. Bulliardi* or *N. Clypeus.* The European *N. Bulliardi* differs in the rather indistinct ostiola and broadly elliptic ascospores, $9–14 \times 7–9\ \mu$, while *Hypoxylon mediterraneum* possesses coarse papillate ostiola and spores $16–22 \times 6–8\ \mu$.

Sphaeria Clypeus was described by Schweinitz (4) in 1822, and the next year Fries in Systema Mycologicum placed it as a synonym under *Sphaeria nummularia* Bull. ex Fries. Then in 1832 Schweinitz (5) dropped the name *Clypeus,* following Fries, therefore the name was not valid at that time.

The Schweinitz description is couched in such general terms that it will fit any one of several *Hypoxylon* species, and his specimen in Kew herbarium, labeled *Sphaeria Clypeus* L. v. S., is another species, *H. tinctor* (Berk.) Cooke. Also, there is another Schweinitz specimen at Kew, with *Sphaeria marginata* L. v. S. on it, that is *H. mediterraneum,* and Berkeley recognized this by writing across it "*Sphaeria mediterranea* DeNot." From the evidence then of the description and the specimens the specific name *Clypeus* must be rejected.

There is a specimen at Kew of *Sphaeria mediterranea* DeNot. with Jan. 1835, Sardinia, written by De Notaris, and one in Nitschke's herbarium at Munster, also from De Notaris, labeled *Hypoxylon regium* DeNot., and the two are identical, and fully equal to the American form.

The name *Hypoxylon repandoides* Fuckel is represented in Kew by no. *2266,* Fuckel Fung. Rhen. Also, the type of *Nummularia australis* Cooke is in Kew, and both are the same as the American fungus.

Hypoxylon mediterraneum occurs chiefly on oak, but it is also found on almost every deciduous tree. In Georgia the writer has collected it on *Diospyros virginiana* L., De Kalb Co.; *Fagus grandifolia* Ehrh., Union Co.; *Paulownia tomentosa* (Thunb.) Steud., Clarke Co.; *Quercus alba* L., Clarke, De Kalb, Union Counties; *Q. georgiana* Curt., De Kalb Co.; *Q. maxima* (Marsh.) Ashe, Clarke Co.; *Q. montana* Willd., De Kalb Co.; *Q. nigra* L., Bullock, Chatham, Clarke Counties; and *Quercus* sp., Morgan Co.

5. **Hypoxylon microplacum** (Berk. & Curt.) comb. nov.

Diatrype microplaca Berk. & Curt. Jour. Linn. Soc. **10**: 386. 1869.
Anthostoma microplaca Sacc. Syll. Fung. **1**: 298. 1882.
Nummularia scutata Berk. & Cooke, Grevillea **12**: 7. 1883.
Nummularia microplaca Cooke, Grevillea **12**: 8. 1883.
Nummularia gracilenta Sydow, Ann. Myc. **8**: 37. 1910.

The writer has examined the types of *Diatrype microplaca* and *Nummularia scutata* in Kew herbarium, and part of the cotype of *N. gracilenta* from the Philippine Bureau of Science.

This fungus is apparently limited to members of the Lauraceae and Magnoliaceae families. In the writer's herbarium there are Georgia specimens on *Magnolia virginiana* L., Chatham Co.; *Persea pubescens* (Pursh.) Sarg., McIntosh Co.; and on *Sassafras variifolium* (Salisb.) Ktze., Chatham, Clarke, Rabun, and Union Counties.

6. **Nummularia Broomeiana** (Berk. & Curt.) comb. nov.

Hypoxylon Broomeianum Berk. & Curt. Grevillea **4**: 94. 1876.
Hypoxylon cinctum Ferd. & Winge, Bot. Tidssk. **29**: 15. 1908.

The type is a Ravenel specimen from South Carolina, no. *1894*, now in Kew herbarium. The stroma is elliptical to orbicular, 2–4 cm. in diameter, and 4–10 mm. thick, with concave surface, with an abruptly rounded margin. The actual fungous stroma is only 1–1.5 mm. thick and the dark substance, apparently composing the rest of the stroma, is decomposed wood mixed with hyphae. Ellis and Everhart (2) have it under "Large, irregular, fibrous within (Macroxylon)," when actually it is of about the same thickness as *Hypoxylon mediterraneum*. The concave disc and sunken perithecia place it in *Nummularia*.

This fungus is fairly common in the tropics, but is rarely found in the southern United States. The writer has collected it only once near Athens, and then it was widely scattered over the entire trunk and branches of a fallen ash tree—*Fraxinus pennsylvanica* Marsh. v. *lanceolata* (Borkh.) Sarg.

7. **Pleosphaeria echinata** (Ellis & Ev.) comb. nov.

Cucurbitaria setosa Ellis & Ev. Proc. Acad. Phila. **42**: 241. 1890.

Berlesiella setosa Sacc. Syll. Fung. **9**: 915. 1891.

Cucurbitaria echinata Ellis & Ev. N. Am. Pyren. 240. 1892.

Gibberidea setosa Kuntze, Rev. Gen. 3^3: 481. 1898.

The perithecia are superficial, gregarious, semiglobose, cupulate-collapsing with age, black, and covered with spines. The asci are clavate with subulate bases, and embedded in paraphysoids, and the ascospores are muriform, brown, 18–20 $\times$ 7–10 μ.

In the writer's herbarium the collections, which have been compared with the Ellis type, consist of free perithecia without a stroma, and are growing parasitically on an old *Hypoxylon rubiginosum.*

Ellis described this fungus as *setosa,* and later discovering there was already a *Cucurbitaria setosa,* he changed the name to *echinata.* In the meantime Saccardo (l.c.) placed the species in *Berlesiella,* evidently misinterpreting the *Hypoxylon* stroma.

Berlesiella is characterized by perithecia in a stroma, but projecting, setose, with ascospores hyaline, and as there is no stroma here the concept does not include this species. Also, it cannot fall in *Cucurbitaria* Gray., because of the lack of a stromatic base. The muriform spores will prevent a position in *Gibberidea* Rab. Then, according to Clements & Shear (**1**), the genus *Pleosphaeria* Speg., with perithecia superficial from the first and hairy, is the only one in the phaeodictyae which could include the characters of this Ellis species.

There is a common Phaeodictyae group of closely related species now in *Cucurbitaria, Fenestella, Pleospora, Teichospora, Pyrenophora,* and *Pleosphaeria,* which have asci embedded in paraphysoids as well as muriform spores, and so belong in the Pseudosphaeriales. The present separation lines are extremely vague and they should be reworked and segregated according to more natural lines.

In Georgia this fungus has been collected on *Hypoxylon rubiginosum* on *Acer rubrum* L. and *Fraxinus pennsylvanica* Marsh. v. *lanceolata* (Borkh.) Sarg. in Clarke Co.

The question of *Sphaerella* (Fries) Rab. (1856) versus *Sphae-*

rella Ces. & DeNot. (1863), emend. Sacc. (1875), *Sphaerella* Sommerf. (1824), *Carlia* Rab. (1857), and *Mycosphaerella* Johans. (1884), is adequately discussed by the Committee on Nomenclature of the British Mycological Society (7). Their recommendation is that *Sphaerella* (Fries) Rab. with type, *Sphaerella punctiformis* (Pers. ex Fries) Rab., be conserved against *Sphaerella* Sommerf., and that *Mycosphaerella* Johans. be rejected. This is in line with the Saccardo Sylloge, which continues to transfer *Mycosphaerella* species to *Sphaerella.*

The objections to this course are that practically all modern American descriptions have been in *Mycosphaerella,* and that *Sphaerella* cannot be used as it is a previous homonym for *Sphaerella* Sommerf., which is still being used in modern texts on algae. In "Fresh water algae of the United States," by G. M. Smith (1933), and "The algae and their life relations," by J. E. Tilden (1935), there is the family Sphaerellaceae, and the genus *Sphaerella* Sommerf. To make this change now would certainly add much to the existing confusion, which is not the intent of the rule on conservation of genera.

In Ellis & Everhart (2) there are many species described under *Sphaerella* that occur in Georgia and have apparently never been transferred to *Mycosphaerella.* The list below includes those collected by the writer or by H. W. Ravenel from the Darien station. All of them develop perithecia in the spring on fallen leaves of the previous season.

8. **Mycosphaerella aquatica** (Cooke) comb. nov.

Sphaerella aquatica Cooke, Jour. Bot. **21**: 106. 1883.

On *Quercus nigra* L., McIntosh Co. (Rav.), Clarke Co.

9. **Mycosphaerella Bumeliae** (Cooke) comb. nov.

Sphaerella Bumeliae Cooke, Grevillea **7**: 54. 1878.

On *Bumelia* sp., McIntosh Co. (Rav.).

10. **Mycosphaerella caroliniana** (Wolf) comb. nov.

Sphaerella caroliniana Wolf, Jour. Elisha Mitchell Soc. **41**: 94. 1925.

On *Oxydendrum arboreum* (L.) DC. Clarke, Gwinnett, Hall, Rabun Counties.

11. **Mycosphaerella Catesbeyi** (Cooke) comb. nov.

Sphaerella Catesbeyi Cooke, Grevillea **7**: 53. 1878.

On *Quercus Catesbaei* Michx. McIntosh Co. (Rav.).

12. **Mycosphaerella Corni** (Schw.) comb. nov.

Sphaeria Corni Schw. Trans. Am. Phil. Soc. II. **4**: 225. 1832.
Sphaerella cornicola Cooke, Jour. Bot. **21**: 108. 1883.
Mycosphaerella cornifolia Lindau. E. & P. Nat. Pfl. **1**^{1}: 425. 1897.

On *Cornus florida* L. Clarke Co.

13. **Mycosphaerella Gordoniae** (Cooke) comb. nov.

Sphaerella Gordoniae Cooke, Jour. Bot. **21**: 108. 1883.

On *Gordonia* sp. McIntosh Co. (Rav.).

14. **Mycosphaerella oleina** (Cooke) comb. nov.

Sphaerella oleina Cooke, Jour. Bot. **21**: 107. 1883.

On *Osmanthus americana* (L.) B. & H. McIntosh Co. (Rav.).

15. **Mycosphaerella pyrina** (Ellis & Ev.) comb. nov.

Sphaerella pyrina Ellis & Ev. North Am. Pyren. 275. 1892.

On *Pyrus sinensis* Lindl. X *Pyrus communis* L. Clarke Co.

16. **Mycosphaerella staphylina** (Ellis & Ev.) comb. nov.

Sphaerella staphylina Ellis & Ev. Jour. Myc. **3**: 128. 1887.

On *Staphylea trifolia* L. Clarke Co.

The name, *Sphaeria Staphyleae* Schw., according to Ellis (N. Am. Pyren. 299) is represented in the Schweinitz herbarium by a sterile specimen.

17. **Guignardia Magnoliae** (Schw.) comb. nov.

Sphaeria Magnoliae Schw. Trans. Am. Phil. Soc. II. **4**: 226. 1832.

Sphaerella Magnoliae Ellis, Bull. Torrey Club **9**: 74. 1881.

Laestadia Magnoliae Sacc. Syll. Fung. Addenda **2**: XXXI. 1883.

This fungus, having no paraphyses, fasciculate asci, and differing from *Mycosphaerella* only in the possession of one-celled ascospores, falls in the genus *Guignardia* Viala & Ravaz.

Ellis & Everhart (N. Am. Pyren. 259) say, "There is no specimen of this species in Herb. Schw., so that we can not be sure that the specimens in N. A. F. are the *S. Magnoliae* Schw." Usually it is impossible to accurately determine leaf pyrenomycetes without descriptions of spores as well as macroscopic characters, but in this case the Schweinitz description is exact enough to separate this fungus from the others on the magnolia leaf.

On *Magnolia virginiana* L. Richmond and Washington Counties.

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A NEW GENUS OF HYPOCREALES

Cloyd Burnley Stifler

(with 6 figures)

In December 1939 Dr. Alfred E. Emerson of the Zoölogy Department of the University of Chicago, known for his work with termites, gave me for identification a fungus parasitic on termites. Two infected insects were collected on January 5, 1935, below Great Rift Wall, Lake Manyara, Tanganyika, Africa, by Dr. Harold Kirby of the department of Zoölogy of the University of California at Berkeley, California. These termites, as determined by Dr. Emerson, were dealated *Macrotermes natalensis* (Haviland) and were dead when found underneath a stone.

From the thorax of the insect tufts of twenty to thirty erect but curving, clavate, stipitate, cream colored stromata protruded. These varied in length from five to fifteen millimeters. The stipes were smooth, one to two millimeters long and one millimeter in diameter. The tips were sterile and less than a millimeter thick. The thickened fertile portion, one and one-half millimeters in diameter, was roughened by the perithecia as in *Cordyceps,* but on some of the fruit bodies there was a dark gray section near the base of the fertile portion due to darkened perithecia. This suggests that in the mature stroma the fertile portion may be nearly or quite black.

As these specimens had been in alcohol for five years their original color is not known.

Cross sections of the fertile portion show a central mass of colorless hyphae with strands extending radially to the perithecia which lie in a single layer on the exterior. The perithecia contain spores in all stages of development, hyaline when young and black when mature; moreover there are only two spores in each ascus, and while the ascus apparently disappears as the spores ripen the two spores still adhere to each other on the flattened inner sides while the tips are slightly divergent.

In contrast to *Cordyceps* the asci are clavate and long stiped and the mature spores are black, non-septate, broadly elliptical, thick-walled, unequilateral, and somewhat pointed. In appearance they suggest a pair of coffee beans.

No reference to a fungus with these characteristics was found in any of the literature examined and a description of the fruiting body with a slide on which a cross section of the specimen had been mounted was sent to Dr. Fred J. Seaver. After he and Dr. B. O. Dodge had examined it Dr. Seaver wrote that they could offer no idea as to its identity and suggested that I should name it. Hence this paper.

Miss Edith Cash has examined the more recent literature and found no description of it. Dr. J. E. Bequaert of Harvard University also thinks that it is a new type of fungus.

There may be errors in the description because the specimens have been in alcohol, but according to the facts in hand the specimen undoubtedly is an ascomycete and a pyrenomycete belonging to the order Sphaeriales, the family Hypocreaceae section Phaeosporae (see Clement and Shear, The genera of fungi).

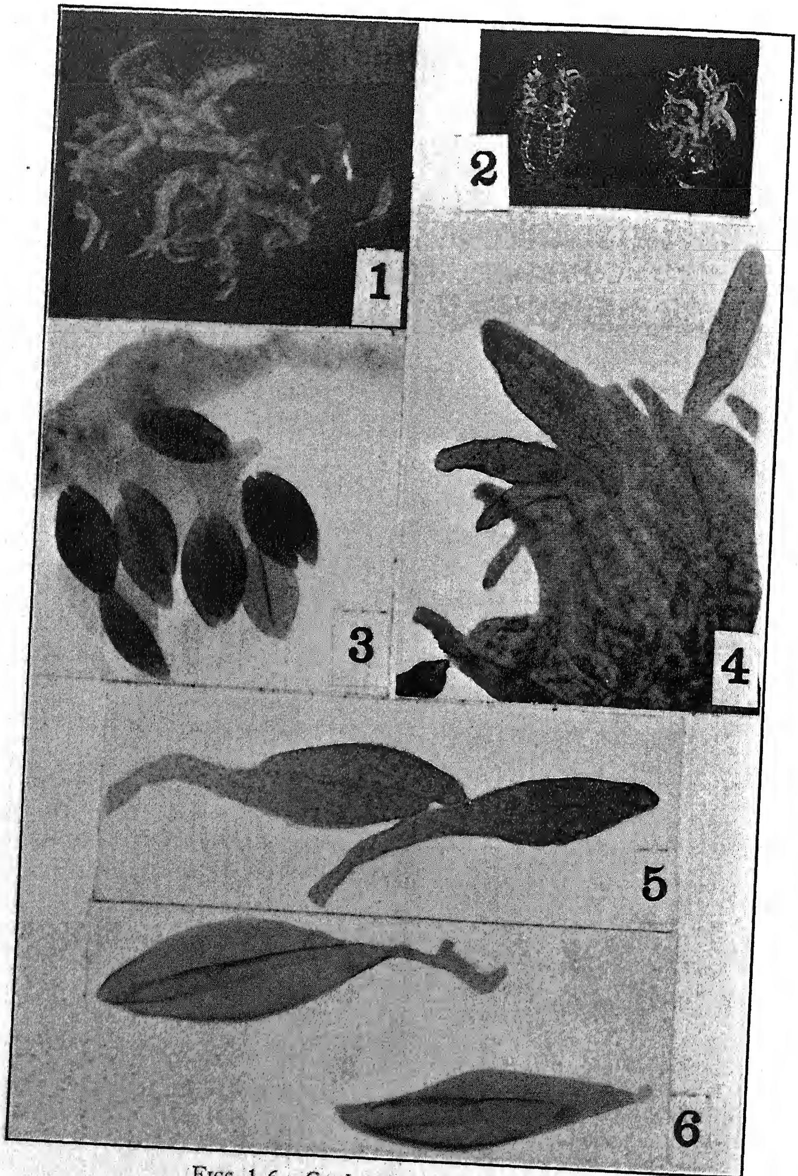
It has an erect stroma growing from an insect and is so like *Cordyceps* that the name of the genus should indicate it. I suggest *Cordycepioideus*, while the species name should indicate the unusual number of spores in the ascus. The name of the specimen then should be *Cordycepioideus bisporus*.

Attempts were made to study the cytology of the spores in order to discover the number of nuclei present. Dr. John M. Beal stained the material and prepared slides for such study. These, however, were not satisfactory as there had been too much shrinkage of the specimen in alcohol.

Cordycepioideus gen. nov.

Stroma carnosum, stipitatum, erectum, capite clavato, entomogeneum, simplex aut plus minusve, ramosum. Perithecia in stroma immersa. Paraphysibus nullis. Ascis clavatis, in stipem attenuatis, bisporis. Sporidia biserialia, elliptica, continua, atra, unilateraliter plana.

Stromata springing from mycelia within the body of a dead insect, erect simple or branched, clavate, producing perithecia which are immersed in the clavate head, the apex of which is sterile.



FIGS. 1–6. *Cordycepioideus bisporus.*

Paraphyses none. Asci clavate with long stipe, evanescent, two-spored, spores broadly elliptic, slightly flattened on one side dark colored.

Cordycepioideus bisporus sp. nov.

Stroma carnosum, stipitatum, cespitosum, simplex vel dichotomum, erectum vel flexuosum. Apice nudo et tenuissimo. Clavula pallida perithecigera et perithecia subsuperficialis, tuberculosa, longit. 1.5 cm., crassit. 1.5 mm. Stipites pallidi, longit. 1–2 mm., crassit. 1 mm. Perithecia subglobosa 300–375 × 375 μ. Paraphysibus nullis. Ascis clavatis, longit. 163 μ, crassit. 58–61 μ, (Stipites longit. 68 μ, crassit. 5 μ). Sporidia 2, biserialia, elliptica, continua, cortice crasso, unilateraliter plana, nigricantia, longit. 95–105 μ, crassit. 34–35 μ.

Hab. in cadavere, *Macrotermes natalensis* (Haviland). Tanganyika, Africa.

Stromata erect, clavate occurring in clusters of 20–30, simple or branched, stipe sterile, uniform in diameter, upper fertile portion enlarged with a narrower sterile tip, color cream with perithecia dark when mature. Perithecia globose, 300–375 × 375 μ, containing spores in all stages of development. Asci clavate long stemmed 162–163 × 58–61 μ (Clavate top 95.2 × 58–61 μ. Stipe 68 × 5 μ). Spores, 2 in each ascus, continuous, elliptical closely appressed, and so flattened on one side, thick walled, hyaline at first becoming black—the ends are slightly divergent. 95–105 × 34–35.4 μ.

Hab. *Macrotermes natalensis* (Haviland), near Great Rift Wall, Lake Manyara, Tanganyika, Africa.

Type specimen. Farlow Herbarium Harvard University, Cambridge, Mass.

I wish to thank Dr. John M. Beal for the interest he has taken in this study and for the advice and suggestions he has made, also for the time he has given to the preparation of specimens for the study of the structure of the spores and the photomicrographs which were taken by him.

For the photograph of the specimen itself and the development and printing of all photographs thanks are due to Mr. A. W. Naylor.

Dr. A. E. Emerson is responsible for the identification of the termite and I wish to thank him and Dr. Beal for reading the

manuscript, and Dr. Charles H. Beeson for checking the latin descriptions.

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EXPLANATION OF FIGURES

FIG. 1, *Cordycepioideus bisporus* on *Macrotermes natalensis* (Haviland) (× 2.5); 2, *Cordycepioideus bisporus* on *Macrotermes natalensis* (Haviland) —natural size; 3, photomicrograph showing perithecia containing spores in various stages of development (× 80); 4, photomicrograph of portion of material from a perithecia showing asci containing spores but no paraphyses (× 370); 5–6, photomicrographs of asci and spores (stained with eosin) (× 370).

CERCOSPORA? PHAEOCHLORA DISCOVERED IN CHILE

Anna E. Jenkins and Charles Chupp

(with 1 figure)

Cercospora? phaeochlora Speg.[1] has recently been identified on a specimen of *Lithraea caustica* L., recently received from Chile. The fungus has previously been known only from Argentina on *L. brasiliensis* March., where it is represented in the Spegazzini Herbarium only by the type specimen. This was collected at Buenos Aires, April 1906.

The *Cercospora* from Chile was gathered at Chaimávida, in the province of Concepción on Feb. 10, 1940, by Sigurd Arentsen Steeger, of the Departemento de Sanidad Vegetal, Santiago de Chile, while he was on a trip to collect certain Myriangiales [2] as a contribution to an exsiccati set of these fungi.

The *Cercospora* was fruiting copiously on the leaves of *Lithraea* from Chile as shown by the accompanying illustrations (fig. 1). With the aid of a fragment of the type specimen of this species, contributed from the Spegazzini Institute of the Museum of La Plata, it has been possible to determine that the *Cercospora* from Chile is evidently the same species as that which Spegazzini discovered in Argentina 36 years ago.

The original description by Spegazzini [3] is here quoted for convenience of reference as follows:

"*Cercospora? phaeochlora* Speg. (n.f.)

Diag. Maculae nullae; caespituli hypophylli densissime congesti ac plagulas dense velutinas olivaceas obliquas efficientes, hyphis brevibus olivaceis constituti; conidia subcylindracea 1–5-septata majuscula olivascentia.

Hab. Ad folia languida *Lithreae brasiliensis* in horto Botánico Municipali, Buenos Aires, Apr. 1906.

[1] Spegazzini, C. Mycetes Argentinensis. III. **13**: 441. 1911.

[2] Jenkins, A. E. & A. A. Bitancourt. Myriangiales selecti exsiccati. Ann. Reunião Sul-Americana de botanica Rio de Janeiro **3**: 1938. In Press.

[3] Loc. cit. See footnote 1.

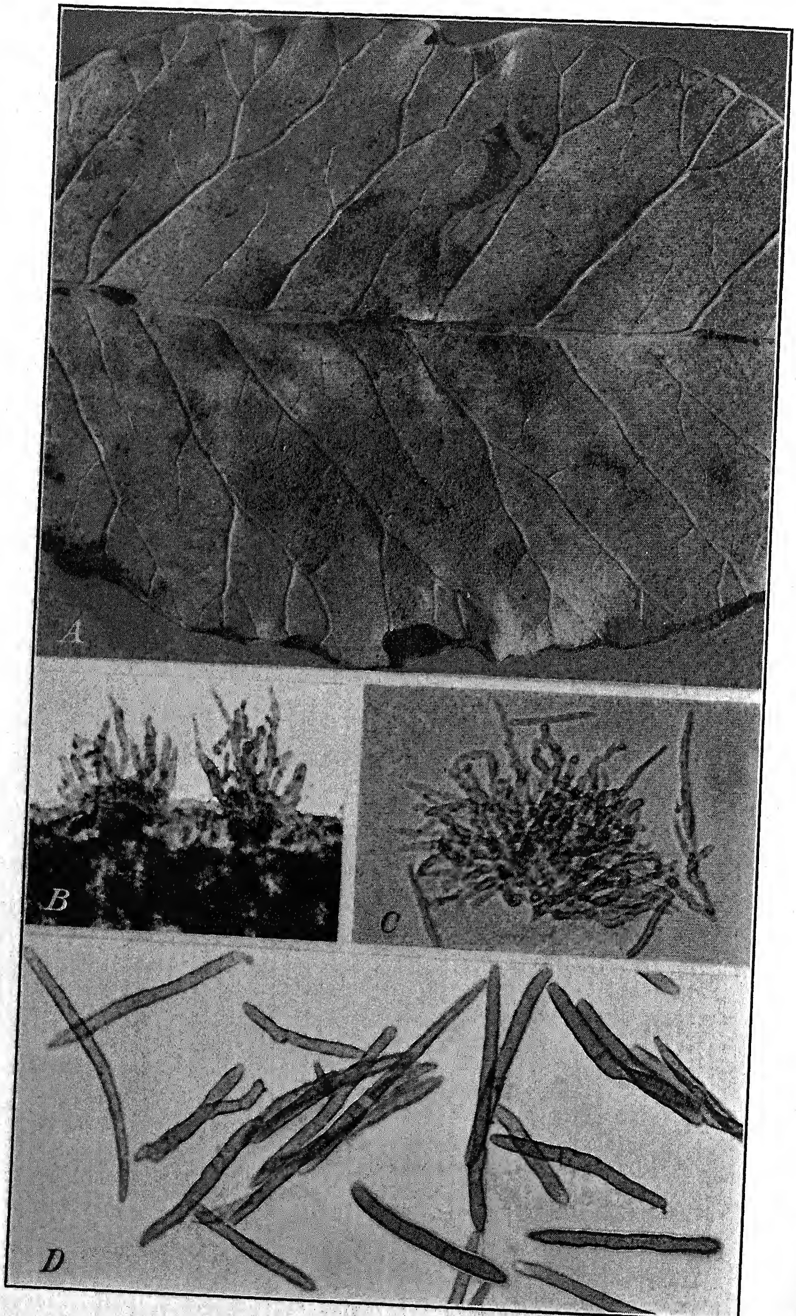

FIG. 1

Obs. Plagulae hypophyllae nervis secundariis transversis limitatae; caespituli superficiales subhemisphaerici ex hyphis confertis simplicibus tortuosulis (30–50 μ = 5–6 μ) continuis v. 1–3-septatis non denticulatis compositi; conidia leniter fusoidea v. obsoletissime clavulata (15–75 μ = 4.5–5 μ) recta v. nonnihil curvula ad septa non constricta."

On the basis of the recent collection from Chile, on which the fungus is abundant, as already stated, a more adequate diagnosis is now possible. This is given as follows:

CERCOSPORA PHAEOCHLORA Speg. Emend. Chupp & Jenkins.

Leaf spots on upper surface none to definite, at first water-soaked areas, then margin turns reddish brown, until finally entire spot attains this color, irregular in shape, 2–7 mm. in length; fruiting hypophyllous, usually in sparingly effuse olivaceous patches on the less plainly colored spots; stroma small, olivaceous; fascicles dense; conidiophores pale olivaceous, uniform in color, irregular in width, sparingly septate (0–3), undulate to tortuous, seldom geniculate, small spore scar at rounded to conic tip, occasionally branched, 3–5 × 10–60 μ; conidia medium dark olivaceous, cylindric, straight to slightly curved, 2–7 or more septate, sometimes constricted at septa, rarely catenulate, base variable from almost sharply obconic to subtruncate, tip bluntly rounded to short conic, 3–5.5 × 20–90 μ.

HOSTS: Leaves of *Lithraea brasiliensis* March., and *L. caustica* L.

DISTRIBUTION AND SPECIMENS EXAMINED: Argentina, Buenos Aires, Apr. 1906, C. Spegazzini. Chile, Chaimávida, Prov. of Concepción, Feb. 10, 1940, S. Arentsen Steeger.

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FIG. 1. *Cercospora phaeochlora* on *Lithraea caustica* from Chaimávida, Province of Concepción, Chile. Feb. 10, 1940, Sigurd Arentsen Steeger. *A*, part of lower leaf surface showing the *Cercospora* as a delicate covering on the discolored area as well as on part of that not yet discolored, × 3; *B* and *C*, fascicles of conidiophores, those in *B*, in situ, that in *C*, separated from the leaf surface, × 250; *D*, conidia with occasional conidiophores, × 500. Photographs by M. L. F. Foubert.

NEW SPECIES OF POLYPORACEAE [1]

L. O. Overholts

(with 12 figures)

In the course of 25 years of collecting and studying American Polyporaceae a very considerable number of collections have seemed to be sufficiently different to justify their being laid aside for further detailed studies and comparisons. Some of these have been sent to European mycologists who have uniformly reported them as unknown to science. That American mycologists have wholly overlooked them heretofore is probably not true—certainly not in some instances. In one case two species with entirely different spores have passed currently under one name, though both are fairly common. The similarity in external appearance did not allow their adequate separation. Undoubtedly some of the obscure names carried in the earlier lists but not accounted for in recent treatments of the family were applied to one or more of these undescribed species. In other cases it is probable that they have actually not been collected previously. Preparatory to a monographic treatment of the family it has seemed best to go over this unidentified material, some of which has for years borne manuscript names in my herbarium, and present the outstanding ones in the present paper. Most of these have been sent in by various correspondents whose names appear in connection with the species. Without the interest of these individuals this paper would not be possible.

Polyporus subcartilagineus sp. nov. (fig. 1)

Sporophore broadly effused, the margin only narrowly reflexed to form a pileus up to 1 cm. long, 2–5 mm. thick, laterally elongated to as much as 8 cm., coriaceous-tough, drying rigid and brittle and

[1] Authorized for publication on May 16, 1939, as paper No. 907 in the Journal Series of the Pennsylvania Agricultural Experiment Station. Contribution No. 130, Department of Botany, The Pennsylvania State College, State College, Pa.

taking several minutes to soak up, at first white, in drying becoming brown- or rufescent-tinted, softly and compactly tomentose, curling away from the substratum and showing on the exposed lower surface a hard, dry, more or less resinous-gelatinized layer; context tough, almost cartilaginous in the fresh condition, about 1 mm. thick, pallid, taste mild; tubes 1–3 mm. long, the pore surface creamy-white when fresh, thin, unequal, fragile in the dried condition, the pores averaging 2 to 3 per mm.; context hyphae somewhat gelatinized, 3–6 μ diameter, with a small staining lumen, hyaline, cross walls and clamps rare or absent; spores ellipsoid or elongate-ellipsoid, smooth, hyaline, 4.5–6.5 $\times$ 2–3 μ; cystidia none.

Type, on log of *Picea*. Notakim Depot, 80 miles North of Maniwaka, Quebec, Sept. 27, 1938, A. W. McCallum. Herbarium Central Exp. Farm, Ottawa, *8852* (Overholts Herbarium *21573*); also collected at the same place on *Picea Mariana* log, Sept. 17, 1938, A. W. McCallum. Central Exp. Farm Herbarium *8851* (Overholts Herbarium *21574*); also on *Prunus sevotina,* Kane, McKean Co., Pa., Aug., 1939, by W. A. Campbell (Overholts Herbarium *22019*).

The diagnostic features of this species seem to be the subcartilaginous consistency of the sporophores, the rufescent coloration assumed by the pileus but not by the pore surface on drying, the spores that are broader than in other similar species that assume a similar rufescent coloration, and the narrowly reflexed pileus. The rot accompanying the specimens is distinctly of the brown carbonizing type.

Polyporus scrobiculatus sp. nov. (FIGS. 2, 3)

Sporophore substipitate, pileus 2–4 cm. diameter or confluent to 7 cm., thin and pliant, bending double without breaking, the individual pilei varying from circular to flabelliform, white, becoming slightly yellowish on drying, the surface uneven and more or less radiately ridged, glabrous or finely velutinate, the margin thin, sometimes drying cartilaginous or resinous; context white, scarcely more than 1 mm. thick, drying rather fragile, not fibrous; tubes 1–2 mm. long, the pore surface white, drying somewhat yellowish, the mouths angular, thin-walled, quite uneven and irregular, averaging 1½ to 4 per mm.; stems not well developed, usually coalesced at the base, white, glabrous, not more than 1 cm. long, tapering downward and expanding upward into the pileus; context hyphae rather flaccid, mainly thin-walled, 3–5 μ diameter, with occasional

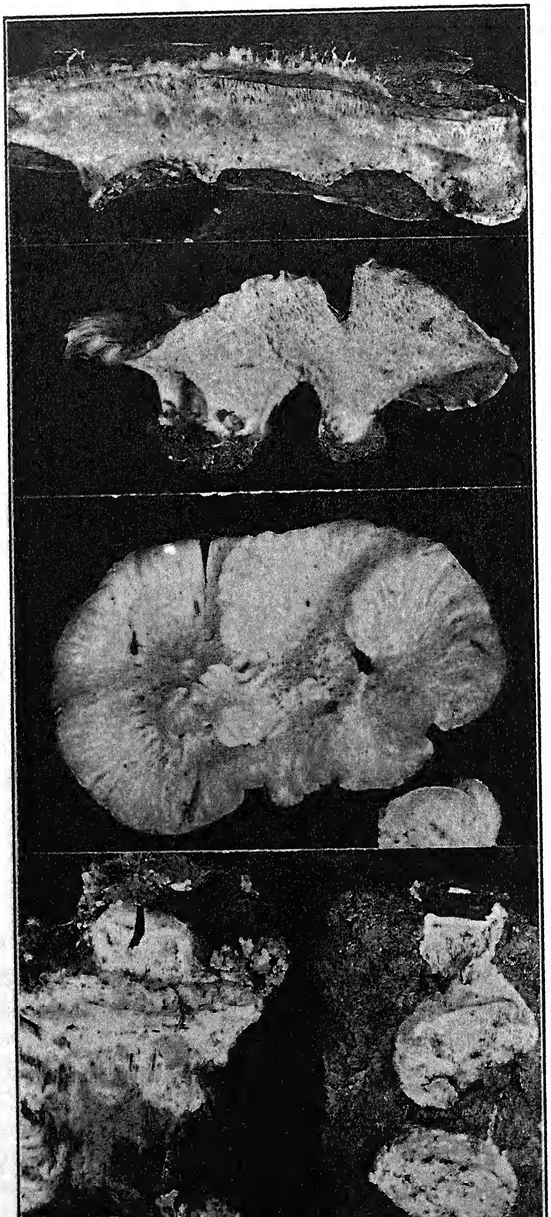

FIG. 1. *Polyporus subcartilagineus*, type collection × 1; 2 and 3, *P. scrobiculatus*, type collection × 1; 4, *P. abieticola*, type collection × 1.

cross walls but no clamps; spores ellipsoid or somewhat elongate ellipsoid, smooth, hyaline, 4–6 × 3–4 μ; cystidia none.

On dead area in living root of *Quercus*. Type collected along Stone Creek, Huntingdon Co., Pa., Oct. 3, 1937. Overholts Herbarium *20376*.

This rather striking species seems to have no near relatives. One can duplicate the external appearance of the sporophore in a number of species but in each such case the spores are a distinctive factor. Perhaps the closest resemblance is to a substipitate form of *Polyporus pubescens*. The stem is too well developed for it to be a substipitate form such as one finds occasionally in sessile species growing on the top surface of their substratum. The texture is more that of the *P. pargamenus-P. pubescens* group than of the more fragile species of the *P. albellus* group. It has some resemblance to unusually well developed specimens of *P. semisupinus,* but the texture and especially the spores are different.

Polyporus abieticola sp. nov. (FIG. 4)

Sporophore sessile or strongly decurrent on the substratum, scarcely imbricated, the pileus 0.5–1 cm. long, 1–5 cm. broad, 2–7 mm. thick, watery and rather coriaceous when fresh, bending without breaking, pale watery buff to watery-brown, very compactly tomentose, the margin rather thick, in vertical section triangular; context homogeneous, tough, not brittle on drying, pallid, 1–5 mm. thick, taste mild; tubes 1–3 mm. long, their mouths subcircular or circular, rather thick-walled, entire, averaging 3 to 4 per mm.; context hyphae long and flexuous, sparingly branched, 2–4 μ diameter, the walls partly or almost completely thickened, no cross walls or clamps; spores ellipsoid to subglobose, smooth, hyaline, minute, 2.5–3 × 2–2.5 μ; cystidia none.

On dead standing snag of *Abies balsamea*. Type collected at Duchesnay, Quebec, Aug. 24, 1938 (Overholts Herbarium *21571*).

The pileus dries cinnamon-brown, the pore surface pallid or straw color. There are so few species with the minute spores of this one that few comparisons can be made. It differs from *P. canadensis* in not drying fragile and not being at all fragile when fresh, and the hyphae are of the type of the more coriaceous species of the genus, without either septa or clamps and with thickened walls. The spores are entirely different from *P. anceps* which

perhaps it resembles most closely, and it lacks the dendritic hyphae of that species.

Polyporus sylvestris sp. nov. (FIG. 5)

Sporophore stipitate, single or in clusters, the clusters composed of 3 or 4 confluent pilei with the stems also partially united, the entire mass or the single pilei up to 15 cm. diameter; pilei appar-

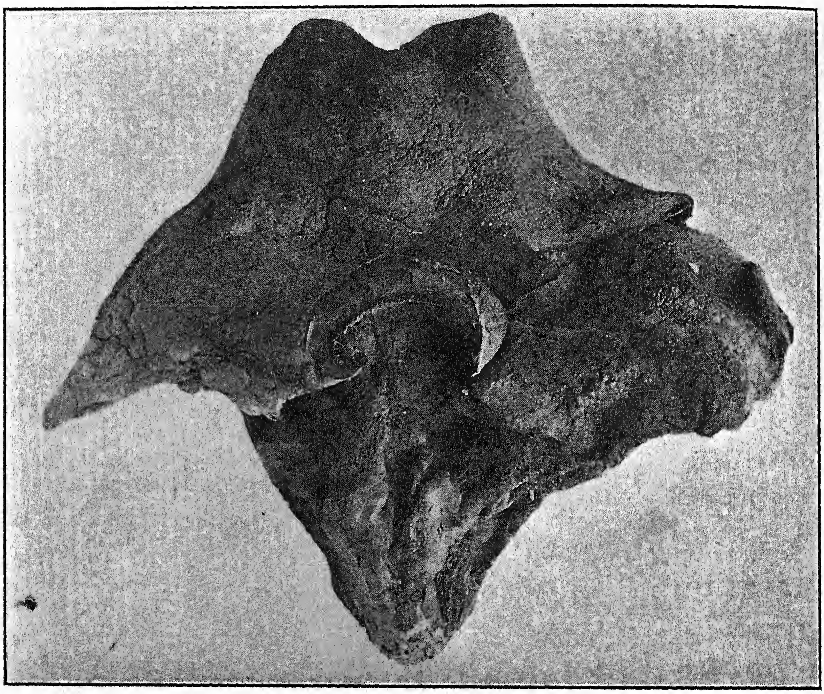

FIG. 5. *Polyporus sylvestris,* type collection × 1.

ently fleshy-tough when fresh, drying rigid, olive ochre to isabella color (R) when fresh, greenish blue around the edges where bruised, sordid yellowish-green in dried plants, covered with a mat of short coarse yellowish-green fibrils that separate slightly into inconspicuous scales or form more or less of a minutely tufted plush over the surface; context watery white when fresh, umber in dried plants, up to 3 cm. thick at the stem, homogeneous, tough, taste mild; pore surface light brownish drab (R) when fresh, smoky-olivaceous or smoky-black in dried specimens, the tubes

2–7 mm. long, their mouths angular, thin-walled, entire, distinctly velvety-pubescent, averaging ½ to 1 per mm. or as much as 2–4 mm. in radial direction, long-decurrent on the stem; stems sub-central or excentric, confluent, concolorous with pileus at base, covered by the smoky-black tubes above, 4–6 cm. long, 2–3 cm. thick; spores broadly ovoid, broadly ellipsoid, or subglobose, smooth, or very indistinctly roughened, hyaline, 9–12(–14) $\times$ 7–10 μ; basidia 10–12 μ diameter, with prominent sterigmata up to 10 μ long; cystidia none.

Apparently growing on the ground but perhaps from buried roots. Type collected in the vicinity of Cowichan Lake, Vancouver Island, British Columbia, by C. G. Riley, August, 1929. Overholts Herbarium *13026.* A portion of the type collection also in the herbarium of the Central Experimental Farm, Ottawa, Canada. Also collected at Deer Lake, Olympic Mts., Washington, Oct. 17, 1935, by Alexander H. Smith (*3189*).

This species has the manner of growth and the form shown by most illustrations of *P. confluens,* from which it differs in every other particular, although belonging in the same section of the genus as that species. The salient characters seem to be the growth habit, the yellowish-green pileus with its covering of short coarse fibrils, and the smoky-black pore surface of dried plants. *P. Ellisii* has a very similar pileus covering but its spores measure only 8–9 $\times$ 5–6 μ and are very strongly apiculate. *P. Pes-caprae* is perhaps more nearly related but has tubes 1–2 mm. diameter, the pore surface is not darkened on drying, and the spores are more pointed than in this species. Murrill's *Scutiger oregonensis* has spores like those of *P. Pes-caprae* and its characters are otherwise as in that species where it unquestionably belongs in synonymy. The same may be said in entirety for *P. retipes* Underwood.

Unfortunately the type collection was unaccompanied by notes descriptive of their fresh condition. That collection was turned over to Dr. Mounce at Ottawa who assisted in the diagnosis. Good notes by Smith on fresh condition of his plants have been incorporated here also.

Polyporus illudens sp. nov. (FIG. 6)

Sporophore stipitate, multiplex-imbricate, about 10 cm. broad; pilei numerous, 1.5–4 cm. broad and long, 1–3 mm. thick, fleshy-

tough, irregular, more or less spathulate or petaliform, concave to depressed, color of fresh plant unknown, everywhere brick-red on drying or at least in the herbarium, glabrous, not areolate; context white, watery, 1–2 mm. thick, finally tinted rusty-red in the herbar-

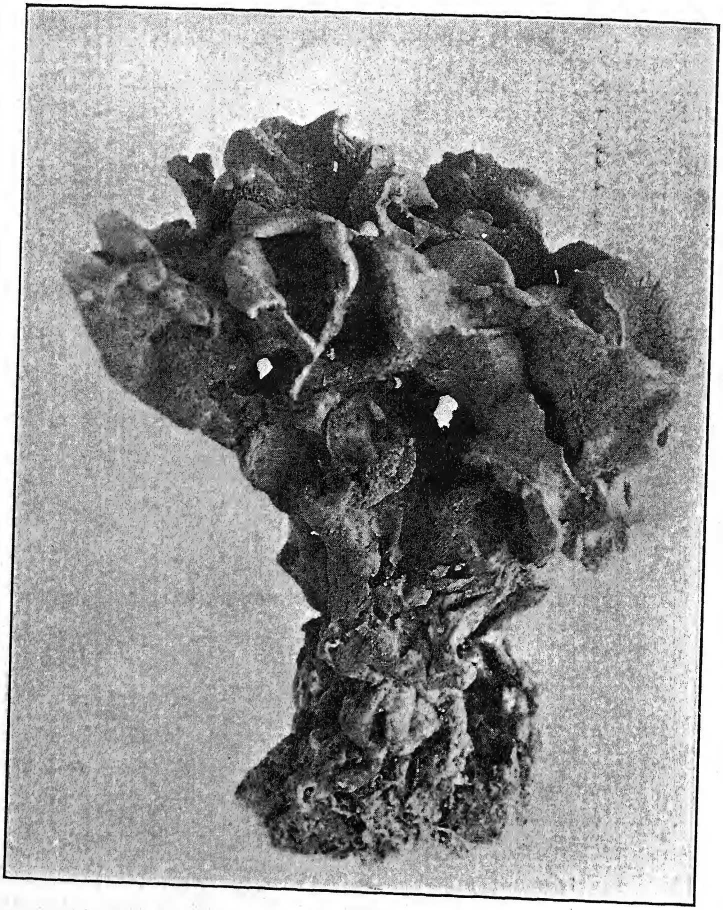

FIG. 6. *Polyporus illudens,* type collection × 1.

ium, changing to cherry-red with KOH solution; tubes about 1 mm. long, their mouths subangular to elongate in a radial direction, entire, rather thick-walled, averaging about 2 per mm.; spores minute, ellipsoid to subglobose, smooth, hyaline, 4–5 × 3.5–4 μ; cystidia none; basidia 5 μ diameter; context composed almost entirely of very irregular hyphae, thin-walled, much inflated, branched, 4–35 μ diameter, no cross walls or clamps.

On the ground in coniferous woods. Type collected at Bovill, Idaho, Sept. 26, 1920, by A. S. Rhoads. Overholts Herbarium *14302*. A portion of the type collection is in the Mycological Collection of the U. S. Department of Agriculture, Washington, D. C.

The form of the plant is much like that of *P. umbellatus,* but it differs microscopically in many points, especially in the much smaller spores, and macroscopically in the brick-red coloration assumed by the entire sporophore in the dried condition. Likewise the spores are smaller than those of *P. cristatus,* and the strongly multiplex habit with small pilei is distinctly different. There is no indication that the plants grew from a tuberoid sclerotium as in a few other species of this section of the genus.

Polyporus canadensis sp. nov. (FIGS. 7, 11)

Sporophore imbricate-sessile with a tendency to be substipitate by a narrowed base, watery-tough when fresh, drying rigid and brittle, the cluster $6 \times 10 \times 5$ cm., composed of about 6 partially confluent pilei; pileus $3–5 \times 3–7 \times 0.3–0.8$ cm., white or watery-white when fresh, drying pallid, densely soft-tomentose with erect tomentose tufts that roughen the surface of dried specimens; context duplex, the upper softer layer consisting of the tomentose covering, white, 2–4 mm. thick, drying fragile, with a sweet odor when fresh; pore surface white, drying somewhat yellowish, the tubes 2–4 mm. long, fragile when dried, their mouths angular, very thin-walled but entire, subshining, 4 to 6 per mm.; spores very minute, subglobose or broadly ellipsoid, smooth, hyaline, 1-guttulate, $2–3 \times 1.5–2\ \mu$; cystidia as inconspicuous paraphysis-like organs slightly larger than the basidia, bluntly pointed at the tips, 4–5 μ diameter; basidia 3.5–4 μ diameter; context hyphae somewhat agglutinated, sparingly branched, thin-walled, septate, with clamps, mostly 4–6 μ diameter.

On stump of *Picea*. Type collected in Dow's Swamp, near Ottawa, Canada, August 16, 1933, by J. W. Groves. Overholts Herbarium *16860* and Herbarium of the Central Experimental Farm, Ottawa, *3593*.

Superficially except for the small pores this resembles *P. borealis*. The very minute spores (seen attached to basidia as well as free and abundant) make this a characteristic species. The habit also recalls that of *P. osseus* from which it is in every other

character distinct. The rough surface of the pileus recalls *P. galactinus* and *P. immitis* and these are its closest relatives. The context is not zonate as in the former species, the spores are a bit smaller, the habitat is different, and the context does not dry resinous. About the same characters separate it from *P. immitis*.

Polyporus durescens sp. nov. (FIGS. 9, 10)

Sporophore sessile, sometimes in imbricate clusters 10 cm. or more broad, tough or corky and watery when fresh, drying quite hard and rigid; pileus dimidiate, 4–12 × 5–15 × 1–4 cm., white or grayish when fresh, unchanged on drying or discoloring to somewhat bay or yellowish, azonate, compactly spongy-tomentose and usually drying rough; margin rather thin; context white, tough and watery when fresh, typically drying very hard and almost horny, 1–3 cm. thick; pore surface white or gray, sometimes somewhat isabelline or discolored on drying, the tubes 0.2–1 cm. long, their mouths subangular, rather thin-walled, entire, averaging 3 to 4 per mm.; spores cylindric, hyaline, 4.5–7 × 1.5–2.5 μ, often attenuate at one end, sometimes slightly curved; basidia 4–5 μ diameter; cystidia none; main context hyphae simple or somewhat branched, with completely thickened walls, no cross walls or clamps, diameter 4–6 μ, others of smaller diameter, about 3 μ, considerably branched, no cross walls or clamps, all non-staining.

On logs and stumps of deciduous trees; noted on *Acer, Fraxinus, Fagus,* and *Quercus.* Type collected at West Elkton, Ohio, on *Fagus* log, July 28, 1917. Overholts Herbarium *4215.* Additional specimens have been examined from New York, Pennsylvania, Louisiana, Kentucky, Ohio and Indiana.

This species is a segregate from plants previously referred by all recent American mycologists to *P. Spraguei,* to which the resemblance is so strong, at least in dried plants, that I am so far unable to separate them without recourse to the microscope. The spores are entirely different in the two species, the basidia are much larger in *P. Spraguei,* and clamp connections seem to be entirely lacking from the hyphae of *P. durescens,* so that the distinction is ample. The basidia of *P. Spraguei* are of the inflated type and 6–8 μ in diameter, while those of *P. durescens* are barely clavate and measure but 4–5 μ diameter. This is one of the few cases in the family where otherwise quite similar species can with

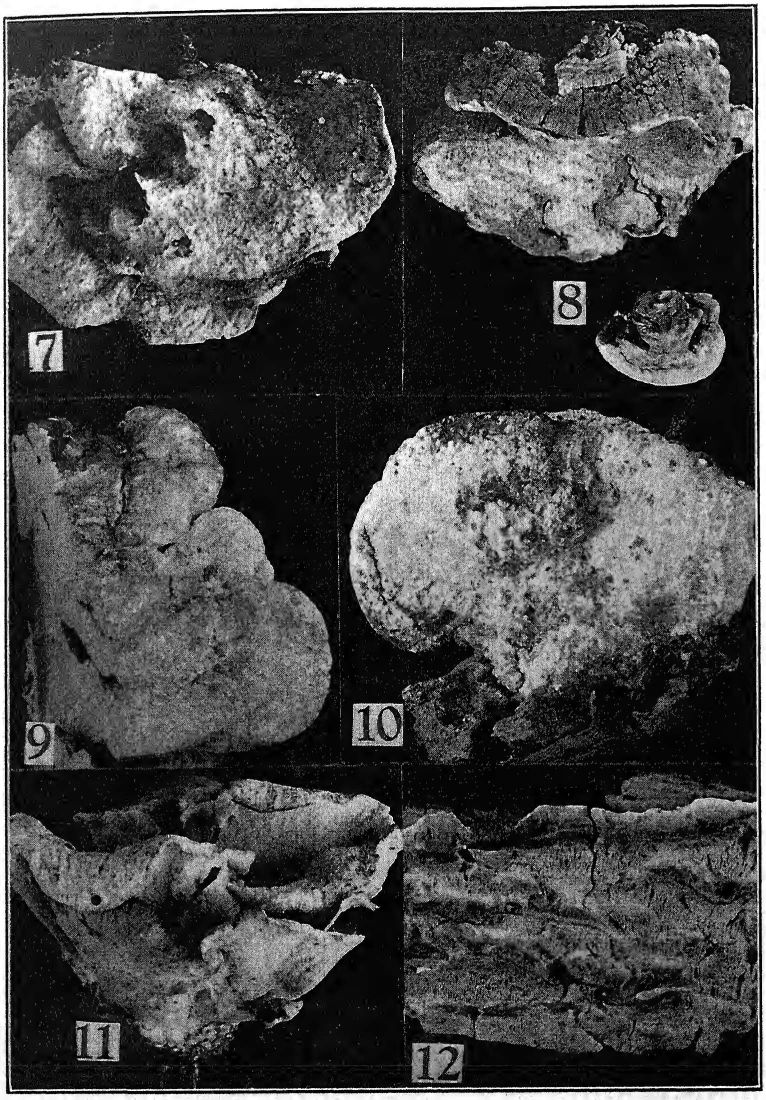

FIG. 7, *Polyporus canadensis,* type specimen × ⅔; 8, *Fomes occidentalis,* type specimen × ⅔; 9, *Polyporus durescens,* Overholts Herbarium no. *19108,* × ¼; 10, *P. durescens,* Overholts Herbarium no. *14699,* × ½; 11, *P. canadensis,* type specimen × ⅔; 12, *P. lineatus,* type specimen × ⅔.

certainty be separated on basidium size alone. The typical blackening of the edge of the pilei in drying in *P. Spraguei* has not been noted in this species nor has the change to green on the margin of fresh plants of that species been noted here, although I am not certain how general that character is in *P. Spraguei.* It has been noted in a number of young and fresh specimens after handling. Not having collected fresh specimens of *P. durescens* in recent years I am also unable to say concerning its odor when fresh. The usual collections made in southwestern Ohio 20 years ago by myself (determined as *P. Spraguei* by all who saw them) were as a rule malodorous. Some of these collections now prove to be *P. durescens,* but I have no odor notes with any particular collection. On the other hand I collected *P. Spraguei* a number of times in recent years and found it to be pleasantly scented in a number of instances. Specimens were sent to Dr. Wakefield at Kew with the request that they be compared with the types *P. Spraguei.* She reported that the types were not in good condition for comparison. Hence it is not certain that the original *P. Spraguei* is the type with globose spores, since no mention is made of spore characters in the original description. It is possible, therefore, that the application of these names should be reversed.

In a single collection where a part of the wood substratum was preserved with the sporophores the decay produced seems similar to that produced by *P. Spraguei.*

Polyporus canaliculatus sp. nov.

Sporophore single, the pileus 9–18 cm. broad, convex-plane or depressed, near dark purplish gray (R) but after prolonged rains cinnamon buff to tawny olive (R), the surface provided with conspicuous olive ochre (R) hairs which are arranged in hirsute reticulations; context 1–2.5 cm. thick next the stem, homogeneous, whitish or grayish, odor and taste mild; tubes not separable, decurrent on the stem, 8–12 mm. long, the mouths mostly about 1 mm. diameter but up to 3 mm., the dissepiments thin, lacerated, circular to elongate, wood brown to avellaneous (R); stem central to almost lateral, equal or tapering upward, not radicating, solid, marked with aborted tubes and coarse reticulations, concolorous with pileus, 5–10 cm. long, 2.5–5 cm. diameter; spores ovoid to subglobose, slightly apiculate, apparently minutely verrucose but actually with the inner spore wall channelled with short tubes, 8–12 $\times$ 8–10 μ cystidia none.

On the ground under species of *Rhododendron*. Type collected at Cades Cove, Blount County, Tennessee, by A. H. Smith and L. R. Hesler, August 10, 1938. In Overholts Herbarium (*21569*), in Herbarium of the University of Tennessee (*11732*) and in the Herbarium of the University of Michigan. Also collected along Indian Camp Creek, Cocke County, Tennessee, August 30, 1938. Smith and Hesler (Herbarium University Tennessee, *11788*).

The diagnostic feature of this species is in the canaliculate spore wall, the condition being similar to that described by Atkinson for *Fomes applanatus* and the species in the *Polyporus lucidus* complex. It differs from both *P. sylvestris* and *P. Pes-caprae* on this point, and from the latter also in the larger spores that are not strongly apiculate.

The description is based almost verbatim on notes furnished by the collectors.

Polyporus lineatus sp. nov. (FIG. 12)

Sporophore largely resupinate with a narrow reflexed pileus 2–8 mm. long, 1–3.5 cm. wide, 1–3 mm. thick, laterally confluent and somewhat imbricate, the upper surface pallid to cinnamon buff (R), perhaps paler when young, sparingly and compactly tomentose, the margin strongly lineate radiate with agglutinated fibrils; context white, 1–2 mm. thick in fresh specimens, soft and fibrous, never fragile; tubes 1–3 mm. long, the mouths white but discoloring somewhat yellowish on drying, circular to somewhat elongate, rather thick-walled, entire, averaging 2 to 4 per mm.; context hyphae septated and clamped, 4–5 μ diameter, rather flaccid but with partially thickened walls and an easily stained lumen; spores cylindric, smooth, hyaline, straight, 4–5 $\times$ 1 μ; cystidia none.

On log of *Pinus rigida*. Type collected at Houserville, Center County, Pa., Nov. 24, 1921. Overholts Herbarium *8023*.

In general appearance there is some resemblance to *Polyporus biformis,* especially in the dried specimens. However, the pileus is thinner, the pores smaller, and the spores both narrower and shorter. The pileus is tough and coriaceous when fresh, hence the species is unrelated to the *P. albellus* group. The rot associated with this fungus is of the brown carbonizing type.

Fomes occidentalis sp. nov. (FIG. 8)

Sporophore perennial, largely rupsinate but where best developed showing a pileus 1–2 cm. long, 4–5 cm. broad, 0.5–1 cm. thick,

hard and woody, the growing margin light-colored and finely tomentose, the older pileus surface becoming black, only indistinctly narrowly subzonate or not at all zonate, not incrusted, not cracked, rather even; context dark brown, black with KOH, woody, only about 1 mm. thick; tubes becoming as much as 8 mm. long, not layered, gray within, the pore surface dark cinnamon brown or darker, the pores circular, thick-walled, entire, averaging 3 to 4 per mm.; context hyphae brown, sparingly branched, the walls somewhat thickened, 3–4 μ diameter, no cross walls or clamps; spores globose or subglobose, smooth, hyaline, 4.5–6 μ diameter; setae very occasional, sometimes apparently absent, 36–48 $\times$ 12–14 μ.

On trunks of dead and living trees of *Crataegus Douglasii*. The types of this species include two mixed collections in one box in the herbarium of the Office of Forest Pathology at Washington, the numbers being *9484* and *11109*. The former was collected at Saint Maries, Idaho, September 18, 1911; the latter at Priest River, Idaho, August 17, 1911; both by G. G. Hedgcock and J. R. Weir. The two collections cannot now be separated. Portions of these are also in Overholts Herbarium no. *21572*.

The labels for one of the collections bears the note "Common on old trees" and the other is marked "On dead and living trees . . . Common."

After my first study of these specimens I made the notation "Setae none." A second study several years later showed a few scattered setae, but often whole sections were without them. Superficially the species resembles *Fomes Pini*. It is apparently not closely allied to *Fomes pomaceus* var. *Crataegi* as described by Baxter, as might be inferred from the host and a certain superficial resemblance to that species. While the pileus is not incrusted, yet when cut vertically with a sharp knife there is a thin black cuticular layer. This character serves to separate the species from the closely allied *Fomes conchatus* which has a definite black line underlying the tomentum, and which moreover has a much more tomentose pileus, slightly smaller spores, and pores about half the size of those in the present species. Weir apparently recognized this as an undescribed species when he studied it, but did not suggest a name.

STUDIES ON HISTOPLASMA CAPSULATUM AND SIMILAR FORM-SPECIES. III. EFFECT OF HYDROGEN ION CONCENTRATION [1, 2]

Arden Howell, Jr.[3]

(with 5 figures)

It was shown in previous experiments (3) that very good growth of *Sepedonium chrysospermum* and *Histoplasma capsulatum,* in its mycelial phase, was obtained at either 20 or 25° C. Accordingly, the following experiments with these two species were carried out at a temperature of 22 to 23° C. to study the effects of hydrogen-ion concentration. The materials and methods were for the most part the same as those employed in studying the effects of temperature (3). There was relatively close agreement between the results obtained by growing the fungi on potato maltose agar buffered to a hydrogen-ion concentration of approximately 5.5 to 6.0 at 22° C. and on the same medium unbuffered at 20° C. However, it was soon found that this agar did not give uniform results when the experiments were repeated with different lots. Therefore, in order to obtain greater accuracy of results, a modification of the synthetic medium used by Mosher et al (4) was employed. This contained in each liter the following materials:

Medium A

d-glucose	42.5000 grams	$ZnSO_4 \cdot 7H_2O$	0.00175 grams
dl-leucine	0.0080 grams	$FeCl_3 \cdot 6H_2O$	0.00016 grams
dl-B-phenylalanine	0.0080 grams	$MnCl_2 \cdot 4H_2O$	0.00150 grams
l-aspartic acid	0.0080 grams	H_3BO_3	0.00100 grams
Ammonium sulphate	3.000 grams	$CuSO_4$	0.00010 grams
Anhydrous $CaCl_2$	0.0755 grams	Inositol	0.02 mg.
$MgSO_4 \cdot 3H_2O$	0.3550 grams	Vitamin B_1	0.002 mg.
Agar-agar	25 grams		

[1] Contribution No. *185* from the Laboratories of Cryptogamic Botany and the Farlow Herbarium, Harvard University. The material presented herein and that of the two previous papers in this series is a portion of a thesis submitted to the faculty of Harvard University, June 1939, in partial fulfillment of the requirements for the degree of doctor of philosophy in biology.

[2] Presented in part before the Third International Congress for Microbiology, New York City, Sept. 2–9, 1939.

[3] The author is very grateful to Dr. D. H. Linder and to Dr. Wm. H. Weston, Jr., for their assistance in the conduction of the present investigation and in the preparation of this manuscript.

TABLE I

EFFECT OF HYDROGEN-ION CONCENTRATION ON GROWTH

Time in days	Buffer Mixture	KH_2PO_4		KH_2PO_4 K_2HPO_4		KH_2PO_4 K_2HPO_4		KH_2PO_4 K_3PO_4		K_3PO_4	
Sepedonium chrysospermum	Original pH	5.0		5.6		6.5		7.7		8.6	
	Final pH	1.8–1.9		2.1–2.3		3.5–3.6		5.7		5.4	
		A	*B*	*A*	*B*	*A*	*B*	*A*	*B*	*A*	*B*
3		14.33	0.77	12.32	0.54	11.47	0.75	6±			
4		19.54	0.69	17.47	0.77	14.81	0.69	9.62	0.63	7.87	0.36
5		24.37	0.75	23.17	0.69	21.26	1.42	12.88	0.93	11.29	0.13
6										14.66	0.11
7		32.73	1.22	32.26	1.42	30.94	1.33	22.80	0.99	18.86	0.31
8								31.03	2.22	23.61	0.24
28	Aerial mycelium[a]	0		1		10		10		8	
28	Phialospores[a]	½		1		10		10		8	
35	Aleuriospores[a]	0		0		10		4		0[b]	
Histoplasma capsulatum No. M251	Final pH	2.8–3.0		3.0–3.1		3.8–3.9		7.1–7.4		7.9	
11		9.27	0.46	9.87	1.68	9.86	0.88		6±		
15		12.19	0.36	13.54	1.52	13.90	0.82	6.92	1.20		
19		15.68	0.61	15.82	1.83	17.04	1.70	8.17	1.27		
23		16.54	0.26	17.02	1.38	20.17	1.88	9.19	1.54		
27		17.02	0.24	18.40	1.32	25.07	1.38	10.54	1.51		
31		17.22	0.25	18.49	1.45	27.08	1.59	11.89	1.73	6±	
30–35	Aerial mycelium	1		2		5		0		0	
30–35	Aleuriospores	3		4		10		3[c]		1[c]	
Histoplasma capsulatum	M250 Final pH			3.4–3.6		4.8–5.0		7.3–7.4		7.8	
11				10.10	0.56	7.44	0.63		6±		
15				13.62	0.90	10.01	0.94	7.22	0.76		
19				17.46	0.61	12.65	0.87	9.9	1.08		
23				19.14	0.81	14.30	1.33	10.86	1.18		
27				20.74	1.04	17.10	0.89	12.91	1.24		
31				21.79	0.96	18.71	0.87	14.73	1.15	8.1	0.45

A = Average growth in millimeters based on 27 measurements.
B = Standard deviation.
a = 10 signifies greatest relative development
b = at end of 21 days.
c = aleuriospores of smooth, submerged type only.

The hydrogen-ion concentrations were adjusted by means of potassium phosphate buffers which were added to the above nutrient medium according to the following table:

pH	4.8	150 cc. M/5 KH_2PO_4 per liter
	5.6	135 cc. M/5 KH_2PO_4 per liter
		15 cc. M/5 K_2HPO_4 per liter
	6.5	75 cc. M/5 KH_2PO_4 per liter
		75 cc. M/5 K_2HPO_4 per liter
	7.5	100 cc. M/5 K_2HPO_4 per liter
		50 cc. M/5 K_3PO_4 per liter
	8.6	150 cc. M/5 K_3PO_4 per liter

The nutrient solution was made up triple strength, the respective buffer solutions listed above were added to this, and each mixture was then sterilized by filtration through a Seitz filter. The agar alone was made up double strength, sterilized in an autoclave, and the nutrient solution added to the agar when the latter had cooled to approximately 50° C. The mixture was poured at once into

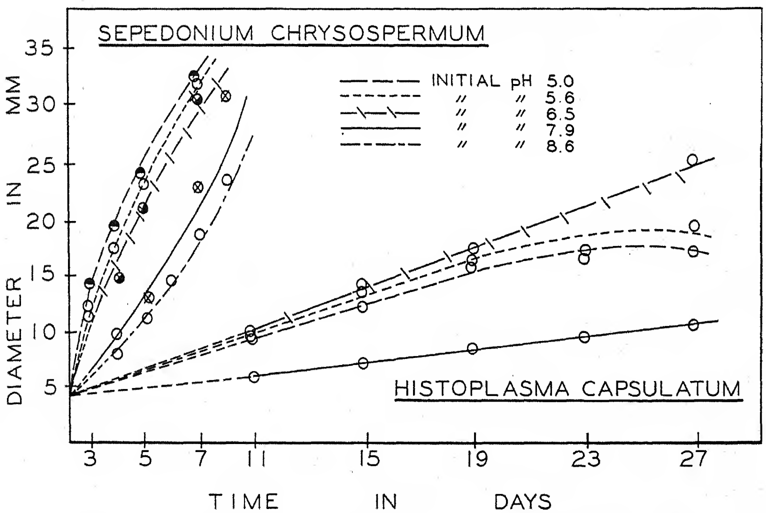

FIG. A. GRAPH TO SHOW RELATION OF GROWTH TO HYDROGEN ION CONCENTRATION

sterile Petri dishes. The hydrogen-ion concentrations were determined by means of a quinhydrone-calomel electrode apparatus. In order to obviate any carry-over effects of the inoculum, the fungi were first grown on the stock experimental medium (Medium A) adjusted to an initial pH of 4.8 to 5.0.

A study of the results obtained (Table I and FIG. *A*) shows that

the optimum hydrogen-ion concentration for *Sepedonium chrysospermum,* under the conditions of this experiment, is an initial H-ion concentration of 6.5 to 7.0, and for the saprophytic phase of *Histoplasma capsulatum* is an initial H-ion concentration of approximately 6.5.

As it was pointed out in the discussion of the effect of temperature on the growth of these fungi (3) measurements of the radial growth alone do not necessarily indicate accurately the total amount of growth. For example, *Sepedonium chrysospermum* exhibited the greatest radial growth, at any time during the course of the experiment, at pH 5.0, the next greatest at pH 5.6, and so forth (FIG. *A*). However, the colonies which developed at pH 5.0 produced no aerial mycelium, and those at pH 5.6 very little aerial mycelium, but those which developed at pH 6.5 to 8.5 produced an abundant, fairly dense, cottony, aerial growth which more than compensated for the slower radial spread.

Sporulation in *Sepedonium chrysospermum* is also affected to some extent by the H-ion concentration of the medium. The production of phialospores seems to be correlated directly with the production of aerial mycelium (Table I), but this does not hold true for aleuriospore formation. The latter appeared only in those colonies which developed on media with an initial H-ion concentration of 6.5 or 7.7 (Table I), but it should be pointed out that at pH 6.5 there was a maximum production of aleuriospores, whereas at pH 7.7 there were slightly less than one-half the number of aleuriospores produced at pH 6.5. Although the greatest radial growth at any given time occurred at pH 5.0, it was only at pH 6.5, where the greatest amount of aerial mycelium was produced, that aleuriospore production was most abundant. In view of the fact that the carbon and nitrogen sources were identical at all H-ion concentrations and also since the concentrations of potassium and phosphate were so great that it would seem that these were above the maximal requirements for the fungi, the writer feels justified in concluding that the hydrogen-ion concentration of the medium has a pronounced effect upon aleuriospore production and a less pronounced effect upon phialospore production.

As was true in the experiments in which the effects of temperature upon the growth and sporulation of *Histoplasma capsulatum*

were studied (3) it was also found that H-ion concentration influenced aleuriospore production and that this was correlated with maximum amount of growth. Thus, the greatest number of aleuriospores were produced at an initial H-ion concentration of 6.5 at which point not only the radial growth, but also the amount of aerial mycelium was greatest (FIG. *A, C*).

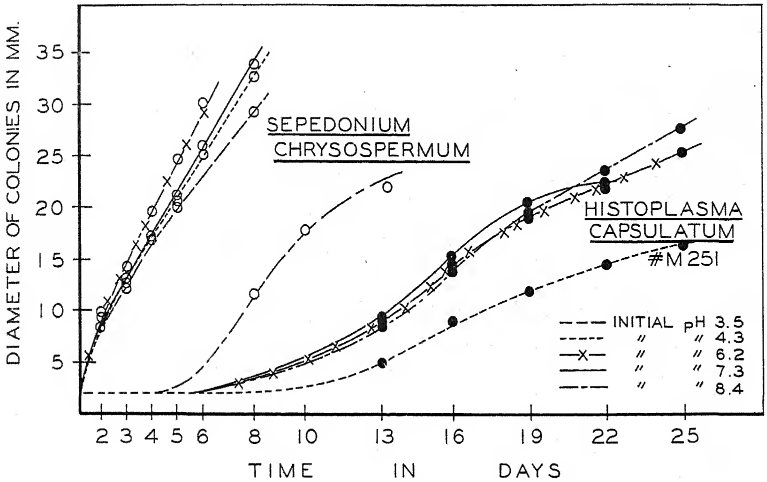

FIG. B. GRAPH TO SHOW RELATION OF GROWTH TO HYDROGEN ION CONCENTRATIONS

In reviewing the results of this work, it was found that although there was a resemblance between *Sepedonium chryospermum* and *Histoplasma capsulatum* in that the optimum hydrogen-ion concentration for both appeared to be 6.5, yet when the colonies were observed more closely, it was found that *Sepedonium chrysospermum* produced little or no aerial mycelium at pH 5.0 or 5.6, but an abundance of aerial mycelium at pH 6.5 to 8.5, whereas *Histoplasma capsulatum* produced considerable aerial mycelium from pH 5.0 to 6.5 and little or none at pH 7.7 to 8.6 (FIG. *C*). In this respect also the two species are distinct. The two strains of *Histoplasma* M250 and M251, were studied at the same time, but since their growth curves were essentially identical (Table I), and also since culture M250 remained sterile or nearly so throughout the experiment, only M251 has been recorded graphically (FIG. *A*).

In the preceding experiment, as may be readily seen from Table

I, large quantities of acid were produced in the media by both *S. chrysospermum* and *H. capsulatum* so that the initial acidity of the media, in each case, was considerably increased. Similar changes in the H-ion concentrations of the medium were reported for other fungi by Cerutti (1) and Harley (2). Cerutti, however, found that on Sabouraud's agar, *Achorion Schoenleini, Sporotrichum Gougeroti* and *S. Schenkii* produced an acid reaction at first, but that this later shifted slowly towards alkalinity. The writer has not been able to duplicate these results, for even at the end of five to seven weeks, there was no evidence for a reversal of the H-ion concentration of the medium. Harley found that the fungi he studied fell into two groups, first those in which the direction and extent of the change in hydrogen-ion concentration depended mainly upon the nitrogen source used in the medium, as with *Neocosmopora vasinfecta,* and second, those in which the change was always toward the acid side, with the extent of the change only dependent on the nitrogen source, as with *Sclerotinia sclerotiorum.* He further reported that such changes in acidity may be due either to absorption of ammonia by the fungus as with *Neocosmopora* or to a release of acid metabolic products as with *Sclerotinia.* The latter, it would seem to the writer, was probable in the case of *Sepedonium chrysospermum* and *Histoplasma capsulatum.* Attempts to identify the acids produced by *Histoplasma* and *Sepedonium* were unsuccessful, but it was found by titration with 0.1 N NaOH that the total amount of acid produced by *Sepedonium chrysospermum* was approximately five times as great as that produced by *Histoplasma capsulatum* when the two were grown on identical media.

Since the acidity of the media in each case was so greatly increased during the course of the preceding experiment, the author attempted to find a medium in which the hydrogen-ion concentrations would remain relatively constant. Medium A contained three grams of ammonium sulphate, forty-two grams of dextrose and 0.024 grams of amino acids per liter. The author felt that the acids that were produced might have been due to the presence of the ammonium sulphate, or to the large amount of dextrose in proportion to the small amount of amino acid. Therefore, the writer first substituted three grams of dibasic ammonium phos-

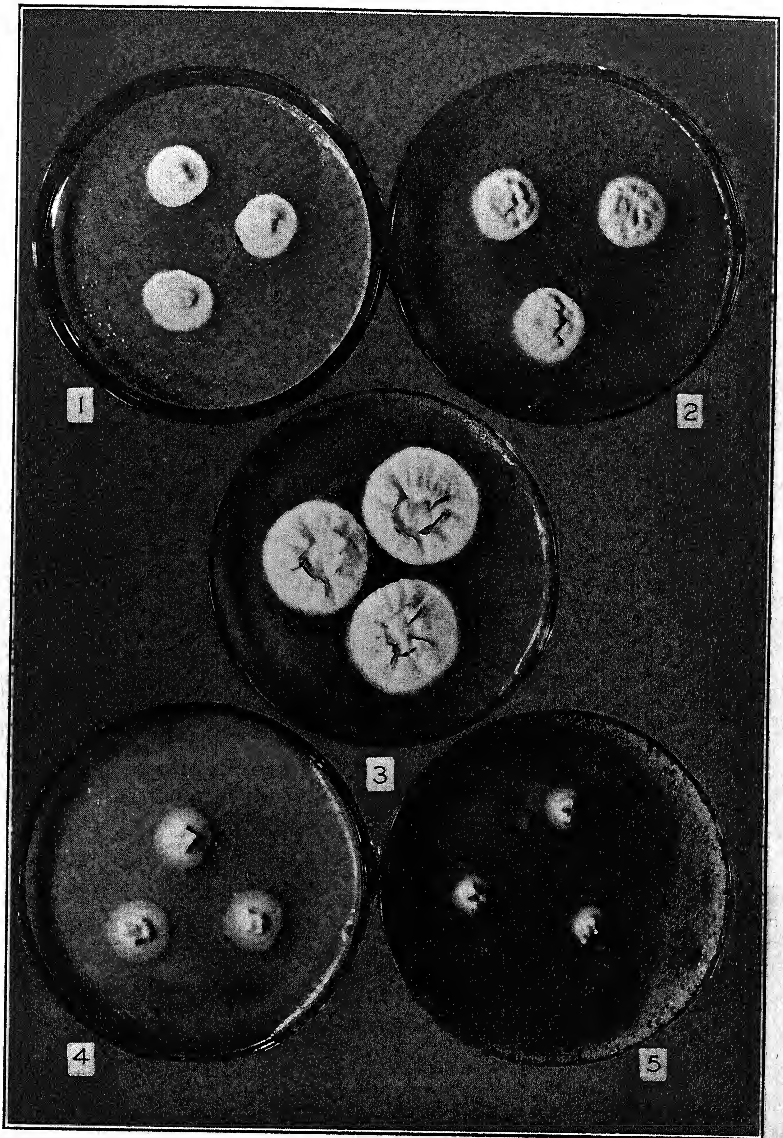

FIG. C. *Histoplasma capsulatum* Darling.

phate $(NH_4)_2HPO_4$, for the ammonium sulphate used in the original medium, and second, altered the ratio of dextrose to the total quantity of amino acids. Several such ratios were employed, as shown in Table II. For these tests the fungi were grown at 22° C. on 100 cc. of buffered nutrient solution in 250 cc. Ehrlenmeyer flasks. The final hydrogen-ion values were determined after five weeks in the case of *Sepedonium chrysospermum* and after seven weeks in the case of *Histoplasma capsulatum*. Excellent growth and sporulation of both species was obtained on each of these media.

TABLE II

MODIFICATIONS MADE IN MEDIUM A AND EFFECT UPON FINAL H-ION CONCENTRATIONS

Medium A	Species	Original pH	Final pH
(1) 5 gms. dextrose/liter	*Histoplasma capsulatum*	6.5	6.2–6.3
1.6 gms. leucine/liter			
1.6 gms. aspartic acid/liter	*Sepedonium chrysospermum*	5.8	6.8–7.0
1.6 gms. phenylalanine/liter		6.3	7.0
(2) 10 gms. dextrose/liter	*Histoplasma capsulatum*	5.5	4.5–5.0
0.8 gms. each of above amino acids/liter		6.5	6.1–6.2
	S. chrysospermum	5.5	6.1–6.3
		6.5	6.4–6.6
(3) 15 gms. dextrose/liter	*H. capsulatum*	6.5	6.1–6.3
0.6 gms. each of above amino acids/liter	*S. chrysospermum*	5.5	5.8–6.0
		6.5	6.1–6.3
(4) 16 gms. dextrose/liter	*H. capsulatum*	5.7	3.9–4.0
0.08 gms. each of above amino acids/liter		6.6	4.5–4.8
	S. chrysospermum	5.7	3.3–3.5
		6.6	6.0

The most striking differences were exhibited when the two species were grown on the medium containing 15 grams of dextrose and 0.6 grams of each of the three amino acids per liter and on the medium containing 16 grams of dextrose and 0.08 grams of each of the three amino acids, or when the ratio of dextrose to total amino acid was 15 to 1.8 or 16 to 0.24. On the former medium neither fungus produced sufficient acid to change the H-ion concentration of the medium more than five-tenths of a pH unit, whereas on the latter medium both fungi produced acids in such quantities that the media became almost as acid as when Medium

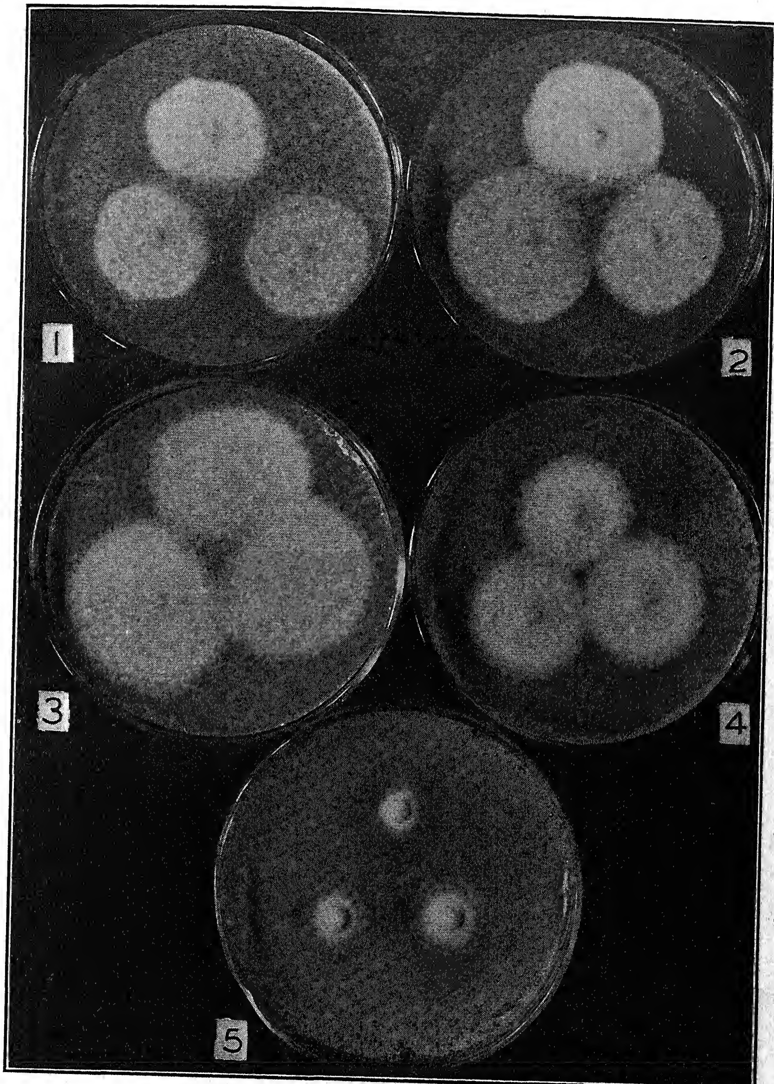

FIG. D. *Sepedonium chrysospermum* (Bull.) Lk.

A was employed. *Sepedonium chrysospermum,* on the medium composed of 5 grams of dextrose and 1.6 grams of each of the three amino acids per liter, and on the medium composed of 10 grams of dextrose and 0.8 grams of each amino acid per liter, the latter adjusted to pH 5.5, produced ammonia in such quantities

that the media became much more alkaline (Table II) and the cultures emitted a decided odor of ammonia. On the other hand, *Histoplasma capsulatum,* on the same media, produced acids in such amounts that the acidity of the media was slightly increased. It would seem from this that there are marked differences between these two species in their metabolic activities, and that there may be differences in the case of *Sepedonium chrysospermum* in the utilization of amino acids at different hydrogen-ion concentrations.

Since it was found in the above experiment that if the composition of the synthetic medium (Medium A) employed in the previous experiment to determine the effect of the H-ion concentration of the medium upon the growth and sporulation of *Hisoplasma capsulatum* and *Sepedonium chrysospermum* were altered by the substitution of dibasic ammonium phosphate for an equal amount of ammonium sulphate, and the ratio of the amount of dextrose to the total amount of amino acids were changed, the hydrogen-ion concentrations would remain fixed or nearly so, the earlier experiment was repeated, using 15 grams of dextrose and 0.6 grams of each of the three amino acids per liter. For convenience this medium is designated as Medium B. The various hydrogen-ion concentrations were adjusted by means of phosphate buffers which were added to the nutrient medium according to the following table:

pH	3.5	90 cc. M/5 H_3PO_4 per liter
		60 cc. M/5 KH_2PO_4 per liter
	4.3	60 cc. M/5 H_3PO_4 per liter
		90 cc. M/5 KH_2PO_4 per liter
	6.2	150 cc. M/5 KH_2PO_4 per liter
	7.3	150 cc. M/5 K_2HPO_4 per liter
	8.4	150 cc. M/5 K_3PO_4 per liter

The results of this experiment are shown in part in Table III and figure *B*. These results show that, under the conditions of this experiment, the optimum hydrogen-ion concentration for *Sepedonium chrysospermum* is an initial pH 6.2 to 7.3, whereas the optimum for the saprophytic phase of *Histoplasma capsulatum* is an initial pH 6.2 to 8.4.

In this experiment, in contrast with previous experiments, measurements of the diameters of the colonies of *Sepedonium chryso-*

TABLE III

EFFECT OF H-ION CONCENTRATION ON GROWTH

	Time in days		Buffer mixture									
			$H_3PO_4 + KH_2PO_4$		$H_3PO_4 + KH_2PO_4$		KH_2PO_4		K_2HPO_4		K_3PO_4	
Sepedonium chrysospermum		Original pH	3.5		4.3		6.2		7.3		8.4	
		Final pH	2.9–3.0		4.2		6.1–6.2		6.2–6.4		6.5	
			A	*B*	*A*	*B*	*A*	*B*	*A*	*B*	*A*	*B*
	2		8.47	0.81	8.48	1.05	9.91	0.99	9.57	0.86		
	3		12.56	1.37	12.50	1.92	14.35	1.44	13.09	0.96		
	4		16.81	1.78	17.06	2.15	19.62	1.47	17.00	1.43		
	5		20.16	2.09	20.82	2.33	24.79	1.57	21.35	1.56		
	6		23.51	2.39	25.30	2.07	30.23	2.19	26.33	1.84		
	8		29.46	2.96	32.99	2.02			34.13	2.16	11.64	1.74
	10										17.86	1.76
	13										22.06	2.75
	13	Aerial mycelium	5[a]		8		10		9			
	19	Aerial mycelium	5		10		10		9		3	
	13	Phialospores	5		8		10		9			
	19	Phialospores	5		10		10		9		3	
	13	Aleuriospores	0		½		3		7–8			
	19	Aleuriospores	0		4		4		10		0	
Histoplasma capsulatum M 251		Final pH	3.4		4.0–4.1		4.6		6.6–6.7		7.0–7.2	
	13		0.00		5±		9.93	1.05	9.76	0.89	8.57	0.85
	16		0.00		9.28	0.59	14.71	0.73	15.56	0.92	14.47	1.23
	19		0.00		12.16	0.69	19.18	0.86	20.96	1.13	19.82	1.14
	22		0.00		14.66	0.62	22.17	0.97	22.66	0.87	23.81	1.55
	25		0.00		16.44	0.53	25.53	1.03	Growth ceased		27.87	1.79
	19	Aerial mycelium	0		4		10		9		9	
	19	Aleuriospores	0		4		10		9		9	

A—Average diameter in millimeters based on average of 27 measurements.
B—Standard deviation.
a—10 signifies greatest relative development.

spermum were a fairly accurate indication of the total amount of growth. For example, the greatest radial growth at any time during the course of the experiment occurred at pH 6.2, the next

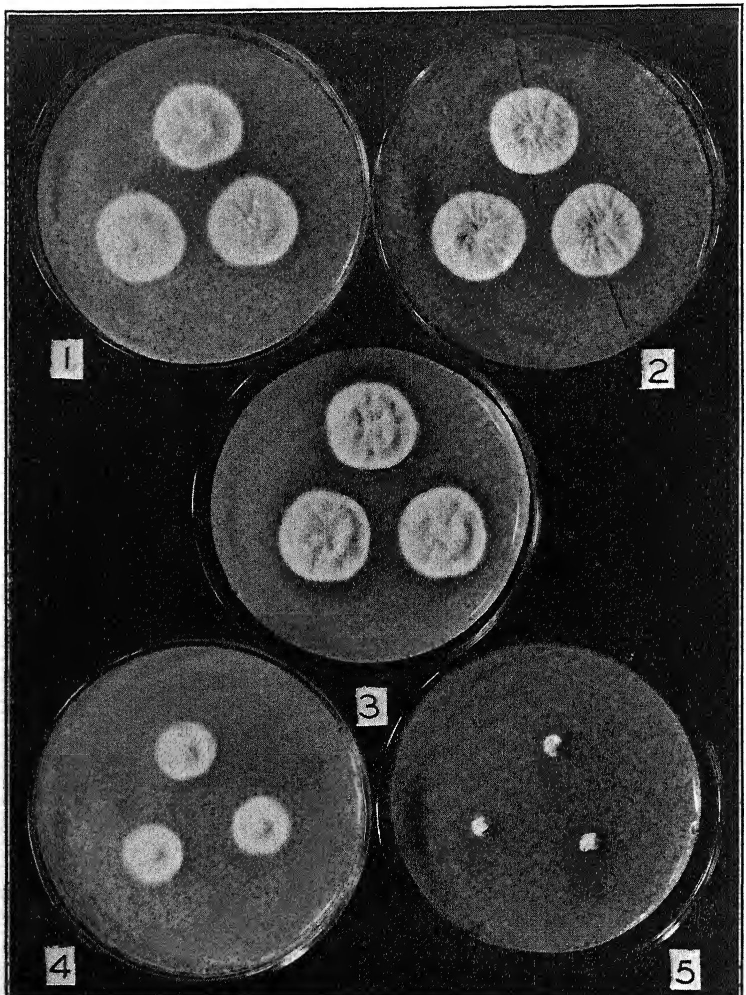

FIG. E. *Histoplasma capsulatum* Darling no. M 251.

greatest at 7.3, and so forth. Likewise, the greatest amount of aerial mycelium was produced at pH 6.2, slightly less at 7.3, and respectively less at 4.3, 3.5, and 8.4 (Table III and FIG. *E*). The

same was true with regard to sporulation, though the greatest production of aleuriospores occurred at pH 7.3. The main exception to the agreement between this and the previous experiment, in which Medium A was employed, was shown by this species when the fungus was inoculated on Medium B at pH 8.4. In this instance there was a considerable lag before the fungus began to grow, but once growth started, the rate (FIG. *B*) was essentially the same. Apparently staling effects became evident earlier as is shown by the decreased growth rate after ten days.

Although, in the cases of both fungi, the H-ion concentrations of the acid media remained constant or nearly so during the course of the experiment, those of the alkaline media were shifted towards the acid side, and the more alkaline the original media, the greater was the increase in acidity.

From a comparison of Tables I and III, it seems to the writer that there is a marked effect of the hydrogen-ion concentration of the medium upon the growth and sporulation of both *Sepedonium chrysospermum* and *Histoplasma capulatum*. On both Medium A and Medium B, used in the two experiments were rate of growth was recorded, the reaction of *Sepedonium chrysospermum* was essentially the same. The reaction of *Histoplasma capsulatum,* however, varied somewhat, apparently depending not only upon the H-ion concentrations, but also on the ratio of carbon to nitrogen in the medium. For example, in the first experiment in which Medium A was employed (Table I) there was little or no growth on the medium adjusted to an initial H-ion concentration of 8.6 and very little growth at pH 7.9, whereas, as shown by Table III and figure *E,* when the ratio of carbon to nitrogen was altered greatly—the total carbohydrate content decreased to approximately one-third of the amount used in Medium A and the total nitrogen content increased seventy-five times, excellent growth was obtained on media adjusted to an initial H-ion concentration of 8.4. Such a difference in growth upon different media adjusted to the same hydrogen-ion concentration is similar to that described for several species of wood-destroying fungi by Wolpert (6) and confirms his conclusions that the range of hydrogen-ion concentrations in which the fungi studied by him would grow depended upon the initial active acidity, the temperature, and the composition of the nutrient

solution. Similarly, Vamos (5) studying several species of parasitic skin fungi, found essentially the same conditions in *Trichophyton gypseum*, *T. rosaceum* and *T. violaceum*. These grew equally well on solid media adjusted to H-ion concentrations between 5.0 and 8.0. *Epidermophyton inguinale* (*E. floccosum*) and *Microsporum Audouini* also grew well over this range, but grew best at H-ion concentrations between 6.5 and 7.2.

Finally, it should be noted that in the case of alkaline media containing magnesium and buffered with potassium phosphate buffers, the double salt, potassium-magnesium phosphate, is precipitated. This presents, to the fungi concerned, a medium of somewhat different composition. In the case of *Neocosmopora vasinfecta*, Harley (2) reported that this fact was of little importance. It may have some influence on the growth of *Histoplasma capsulatum* and *Sepedonium chrysospermum*, though it would seem to the writer, from a study of Tables I and III, and figures *A* and *B* that it has little if any effect upon the growth of these two species.

SUMMARY

The results of the studies of the effects of the hydrogen-ion concentration of the medium upon the growth and sporulation of *Sepedonium chrysospermum* and *Histoplasma capsulatum* may be summarized as follows:

1. The optimum H-ion concentration may vary with the medium. Essentially, however, the optimum point for *Histoplasma capsulatum* is approximately 6.5 to 7.5 and for *Sepedonium chrysospermum* is approximately 6.5 to 7.0.

2. Sporulation, for the most part, is correlated with maximum growth, and consequently is also influenced by the H-ion concentration of the medium.

3. It was found that with the media used in the experiments, when the carbohydrate-amino acid balance was changed, corresponding changes were produced in the acidity of the substratum. Thus, when the ratio of carbohydrates to amino acids was 15 to 1.8 the medium remained relatively constant, whereas when the ratio was 16 to 0.24, the medium became definitely more acid.

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EXPLANATION OF FIGURES

FIG. *A*. Graph to show effect of hydrogen-ion concentration of the medium (Medium A) upon the growth of *Sepedonium chrysospermum* and *Histoplasma capsulatum;* FIG. *B*, Graph to show effect of hydrogen-ion concentration of the medium (Medium B) upon the growth of *Sepedonium chrysospermum* and *Histoplasma capsulatum.*

FIG. *C*. 1–5, *Histoplasma capsulatum* Darling, M251, showing effect of H-ion concentration on growth and sporulation at end of 35 days on Medium A; 1, Medium adjusted to pH 5.0. Colonies small with relatively abundant aerial mycelium; 2, Medium adjusted to pH 5.6; 3, Medium adjusted to pH 6.5. The colonies produce dense aerial growth and abundant aleuriospores; 4, Medium adjusted to pH 7.7. The colonies show lack of aerial mycelium and tuberculate aleuriospores; 5, Medium adjusted to pH 8.6. The colonies in this instance have barely commenced to grow and the mycelium is all submerged.

FIG. *D*. 1–5, *Sepedonium chrysospermum* (Bull.) Link, showing effects of H-ion concentration on growth 10 days after inoculation on Medium B; 1, Medium adjusted to pH 3.5; 2, Medium adjusted to pH 4.3; 3, Medium adjusted to pH 6.2; 4, Medium adjusted to pH 7.3; 5, Medium adjusted to pH 8.4.

FIG. *E*. 1–5, *Histoplasma capsulatum* Darling, M251, showing effect of H-ion concentration on growth after 25 days on Medium B. Compare with FIG. *C;* 1, Medium adjusted to pH 3.5; 2, Medium adjusted to pH 4.3; 3, Medium adjusted to pH 6.2; 4, Medium adjusted to pH 7.3; 5, Medium adjusted to pH 8.4.

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A CHYTRID INHABITING XYLEM IN THE MOLINE ELM [1]

Leo R. Tehon and Hubert A. Harris

(with 14 figures)

Species of such chytrid genera as *Olpidium, Physoderma, Plasmodiophora, Synchytrium,* and *Urophlyctis* have long been recognized as parasitic inhabitants of superficial non-ligneous tissues in short-lived, herbaceous plants. Up to the present, however, only two chytrids have been recognized as inhabitants of deep, ligneous or vascular tissues. These two, both associated with diseases of sugar cane, are *Ligniera vascularum* (Matz) Cook and a recently described but unnamed chytrid to which we shall refer as Carpenter's organism.

It is our purpose to report the occurrence of a chytrid in the xylem tissues of a Moline elm,[2] which in many respects resembles Carpenter's organism.

In May, 1932, we received from E. L. Chambers, State Entomologist for Wisconsin, material from a diseased Moline elm. The tree was about 6 years old, had been grown by a Wisconsin plant nursery, and was one of a number set out 4 years previous as a boulevard planting in the city of Madison. The stock of the tree, American elm, presumably grown from seed by the nursery, had been budded with original Illinois Moline elm. Moline elms grown by the nursery in question had, except for this instance, shown no disease. This tree, however, had given evidence of disease or injury in its terminal shoot in 1931 and, in spite of pruning,

[1] A paper giving essentially the facts reported herewith was submitted for publication in Mycologia in 1933. It did not, of course, refer to Carpenter's organism, which had not then been reported, and did not suggest the formal classification which we now propose in lieu of the term Carpenter's organism.

[2] The Moline elm is a cultivated form of *Ulmus americana* L., which is perpetuated by the budding of seedling American elm stock with buds derived directly or authentically from one original tree growing near Moline, Illinois.

had become so generally diseased in 1932 that it had to be destroyed. The material communicated to us consisted of a stem piece 1½ inches in maximum diameter and a root piece 2 inches in diameter.

The root sample had only very uncertain indications of disease, there being no marked or extensive discolorations in the wood but only short, fine, discrete, widely scattered brownish streaks. The branch specimen was, however, very obviously diseased. When it was cut crosswise, an interrupted ring of badly discolored wood was revealed, occupying most of the 1931 growth ring. The individual patches of discoloration appeared to be associated especially with the large water ducts of the spring wood of that year but extended to a considerable number of surrounding cells so as to form evident oval areas with their long axes radial to the stem. On one side of the stem these discolored ovals were set so close together as to appear continuous, but on the opposite side they were fewer and discrete. In longitudinal view, they appeared as fine, separate, brown streaks generally less than ½ mm. wide, following the courses of the water vessels and anastamosing into a fine network.

Numerous fragments from both the root and the stem samples were planted in nutritive agars and attempts to isolate parasitic organisms were continued for nearly a month. No growths appeared in the plates, however.

In sections cut from both stem and root, at a thickness of 15 to 20 μ, no microscopical evidence of bacterial invasion or of attack by any of the fungi ordinarily seen in elm wood could be found. The discoloration observed macroscopically was, however, seen to be due primarily to a heavy deposition of gum in an excessively great number of tyloses and parenchyma cells. The presence of tyloses and gum deposits in quantities sufficient to obstruct the tracheae often is, in the elm, evidence of disease, this being one of the commonest pathological changes accompanying parasitization of the stele.

Though the expected organisms were not found, the microscopic examination of sections did reveal that in the discolored regions bodies were present which do not occur in normal, healthy elms. These bodies (FIGS. 1 and 4) were minute spheres. They usually

stained very deeply and were limited in occurrence to the lumens of tracheae well occluded by tyloses, appearing oftenest but not always in tyloses. In the many other samples of elm we have

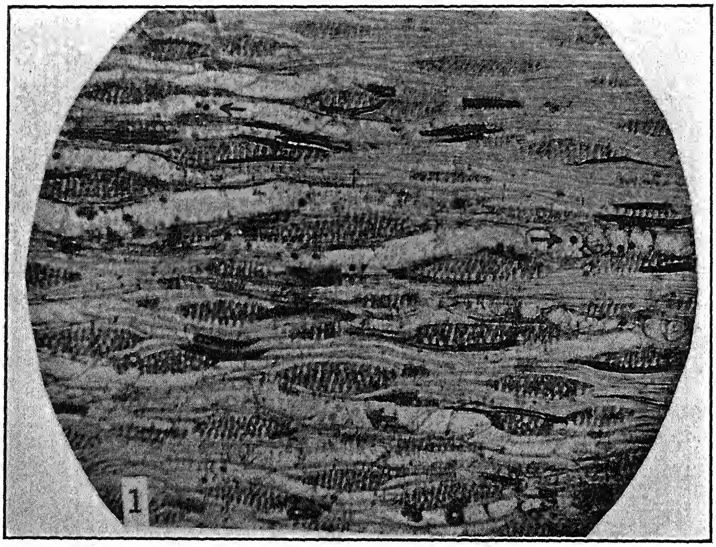


FIG. 1. Oöspores in a tangential section of elm wood, × 100.

examined, we have not hitherto nor since found such bodies, either in healthy or in diseased trees. That they could not be the nuclei of parenchyma cells giving rise to tyloses was clearly evident from their size,[3] reactions to stains, manner of occurrence, and the fact that, when tyloses reach such a stage of development (FIG. 1), nuclei are never found in them.

Though the majority of these bodies stained so deeply as to become practically opaque, individuals which stained less deeply were observed here and there, often in pairs such as can be seen near the arrow in the lower part of figure 1. In these the structure could be ascertained. Surrounded by a definite but thin membrane, they contain a dense, alveolar protoplasm, through which

[3] In American elm parenchyma cell nuclei, after migrating into tyloses, commonly measure 6.5 to 8 μ in diameter in killed and stained sections. For an illustration of such nuclei see fig. 13 in: Tehon, L. R. A *Verticillium* root disease of American elm. Davey Tree Expert Co. Res. Dept. Bull. 6. 1936.

there is scattered a variable number of minute, light-refractive granules and a larger deeply-staining body which can be regarded as a nucleus. In this condition, their diameter is between 15 and 25 μ.

According to the intensity with which these spherical bodies stained, they appeared to have contracted and increased in density, finally having a diameter not far divergent from 10 μ.

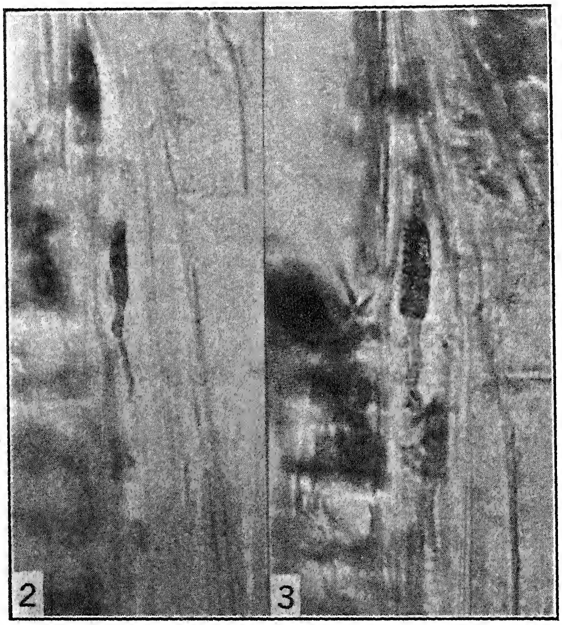
Accompanying the shrinkage in size of the spherical bodies and the increase in their tendency to retain stain, other changes appear to occur. The first of these is the appearance of a lightly staining protoplasmic vesicle applied, or attached, to a portion of the periphery of the sphere. Invariably, when the staining reaction of the sphere is mild, this vesicle is large, often as large or larger than the sphere; but as staining becomes more intense it becomes smaller (FIGS. 5–10), until finally it can be seen only as a small hemispherical to lunate attachment on the surface of the sphere (FIG. 4). By this time the sphere appears to have become incased in a heavy, light-refractive wall, while its protoplasm has become very dense and contains a large, deeply-staining nuclear body. These characteristics are shown photographically in figure 4 and diagrammatically in the somewhat exaggerated drawing (FIG. 11).

The origin of the vesicle seems to be clearly demonstrated. When the spheres stain weakly, they often occur in pairs and lack the vesicle, while when they stain deeply they are not often paired and usually possess the vesicle. This suggests that a union between paired individuals takes place, one possibly functioning as a female gametangium, the other as a male. Shrinkage of the vesicle suggests the emptying of its contents into the spherical cell; contraction of the sphere to a smaller size, coupled with the concentration of its protoplasm and the development of a heavy wall, suggests the formation of a resting spore; and these two phenomena, occurring in the manner described, indicate strongly that the spherical bodies, in their mature form, are oöspores of a Phycomycete.

This interpretation, we realize, can be questioned, since it has been possible for us to observe our organism only *in situ,* by means of microtomic sections of the wood in which it lies. Oöspore germination has not been seen, and zoöspores, if produced, are indicated only by the presence in some host tracheae of numbers of

minute, mononucleate, rounded, plasmodium-like bodies, some few of which seem to possess a single polar cilium.[4]

To support our belief, however, there is evidence of a plasmic or vegetative stage. In cells adjacent to tracheae containing



FIGS. 2–3. Attenuate thalli in fiber cells, × 1000.

spheres, there frequently occur entirely foreign protoplasmic bodies, or thalli, clearly distinguished by stain reaction from the protoplasm of the host.

These thalli are shown particularly in figures 2 and 3 and can also be discerned in figure 4. They are limited in occurrence to xylem cells and, among these, occupy only wood parenchyma, wood fiber, and ray cells. They do not occur in tracheae. They may occupy only a single cell, especially if the cell is a fiber cell not connected by wide pits with adjacent cells. Such a case is illustrated in figure 12. Or they may appear to extend to several cells (FIG. 13), seeming to pass from one cell to another by way of the natural

[4] Attempts at differential staining to bring out clearly such minute structures prove futile, because the stains act also on the lignified cell walls of the host.

pits in the walls of the cells and maintain definite protoplasmic connections through the pits. Also, they may occur singly in a host cell, or two or more of them may be present in one cell.

In the main, the thalli consist of fine, irregular, attenuated strands usually less than 1 μ wide (FIG. 2), which appear devoid,

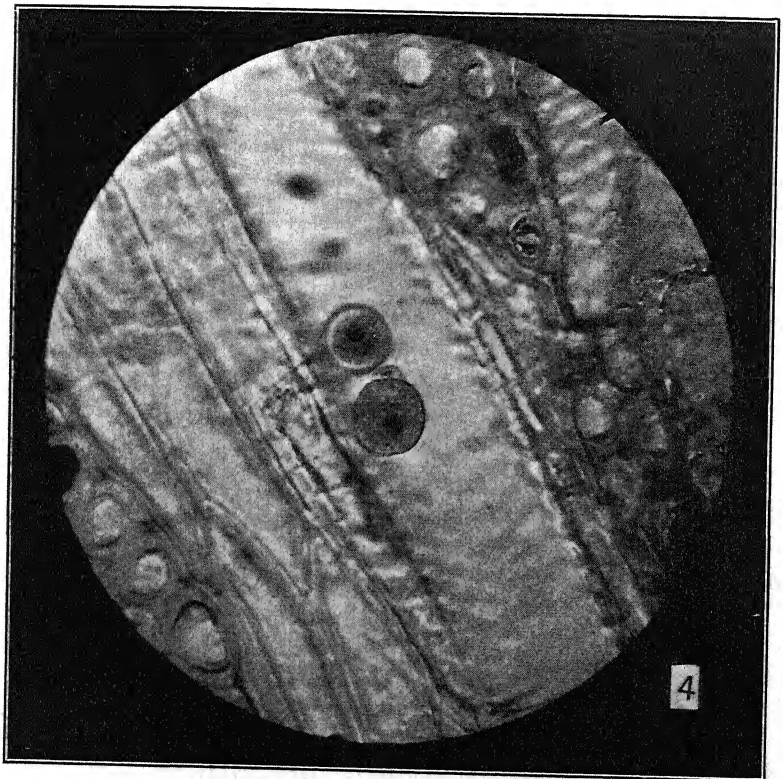


FIG. 4. Oöspores in a trachea, × 1000.

through most of their length, of any covering other than the ectoplast. At intervals, however, the strands flare out into irregular plasmodial expansions as much as 6 μ wide or round up into short, heavy, bead-like strings 3 to 4 μ wide, when they appear inclosed by a definite wall. Such structures as these are shown in figures 3 and 12. There is, also, a noticeable tendency for strands to anastamose into nets (FIG. 14).

A plausible explanation of the formation of the oöspores has

been observed. In figure 4 remnants of a thallus can be seen in the parenchyma cell at the left of the trachea in which oöspores lie. Directly opposite the upper oöspore a fine strand of the thallus has penetrated the wall of its own cell and the wall of the trachea and ends in a small, darkly stained knob lying just within the lumen of the trachea. During our examination of sections many thalli were seen, which had penetrated into tracheae, especially by way of the half-bordered pits. Their tips, lying free in the tracheae, often appeared to have expanded (FIG. 14) into irregular, plasmodial bodies. These apparently soon become detached from their thalli, of which little remains, lie free in the tracheal lumen, and assume a spherical shape.

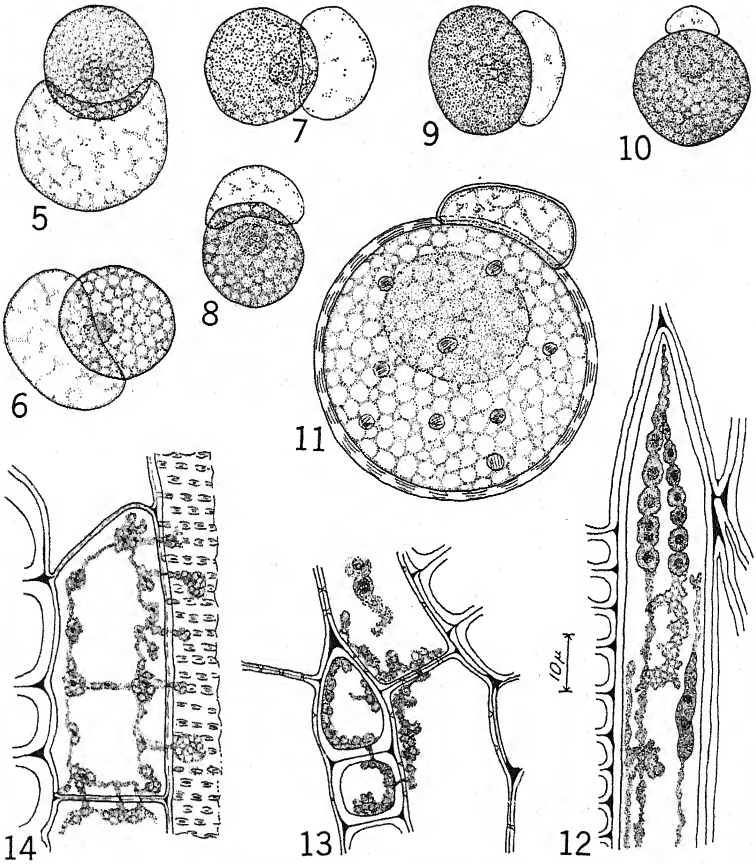
Although it was not possible to watch this process, examples of it were so numerous in our sections, and the observable stages formed a series so continuous, that we do not doubt its actuality.

The circumstance of an endophytic phycomycete parasitizing the vascular tissues of a phylogenetically high, woody plant suggests that the fungus might be a *Pythium*. But in this case all observable facts seem to exclude that genus from consideration. The oöspores are not inclosed in a separate oösporangium; no evidence of fertilization by recognizable antheridia can be found; and, finally, the thallus is far too primitive to permit of its being recognized as mycelium. On the other hand all observable characteristics—the primitive thallus, the identity of oösporangium and oöspore walls, the primitive zygomycetous copulation, and the vesicle on the resting spore—point directly to the Chytridiales.

Within this order, there seems to be no entirely satisfactory disposition for our organism. *Ligniera vascularum* (Matz) Cook, reported by Matz (8) from Porto Rico in 1920, in connection with the yellow stripe disease and dry top of sugar cane, and by Bourne (1) from Barbados in 1922, in sugar cane stalks whose roots had been attacked by *Rhizoctonia Solani* Kuhn, has received detailed study as to both morphology and taxonomy by Matz (9), Melville T. Cook (3, 4, 5) and W. R. Ivimey Cook (6, 7). Through the personal kindness of Melville T. Cook in providing preserved material, we have been able to prepare microtome sections of *Ligniera vascularum* and to compare it with our organism. As all

published accounts indicated, it differs from our chytrid in so many respects that the two cannot be classified in the same family.

Carpenter's chytrid we have not been able to examine. Nevertheless, after making close comparisons with the numerous photo-



FIGS. 5–14. Oöspore formation and types of thalli.

micrographs Carpenter (2) has published, we are of the opinion that his chytrid and ours have many points in common and probably are congeneric. The similarities of the two are morphological, physiological and, perhaps, pathological. They can be cataloged as follows:

Both have spherical bodies, apparently resting spores formed

after conjugation of entire thalli, containing opaque or heavily-staining dense protoplasts, to which structures capable of being regarded as companion cells often are attached. (See Carpenter's *figs. 7* and *11* and our FIGS. 1 and 4–11.) Also, both have protoplasts of two types, one amorphic, amoeboid, and highly vacuolated (Carpenter's *figs. 5B, 6,* and *8B,* our FIGS. 2, 13, and 14) and the other elongated and attenuated but interrupted with flaring or bead-like enlargements (Carpenter's *fig. 10B,* our FIGS. 3 and 12).

Physiologically, both organisms appear adapted to the habitation of living cells in deep-seated plant tissues, with the added peculiarity of not causing, as many other chytrids do, the development of galls or any hypertrophy. Both inhabit vascular tissues, Carpenter's occasionally and ours habitually.

To both a pathogenic rôle can be attributed, questionably. If such a rôle is admitted, the outstanding pathological effects accompanying the presence of each organism are discoloration of vascular strands and deposition of abnormal quantities of gummy substances in the conducting vessels of the xylem.

The vesicle, or companion cell, attached to the resting spore appears to be the one characteristic of our chytrid, and of Carpenter's, upon which exact taxonomic placement can be based. It indicates relationship with either the Woroninaceae or the Olpidiaceae. In the first of these families all known forms are parasites of fungi and algae; and it is, moreover, an apparently essential characteristic of *Olpidiopsis,* the one genus of the family possessing companion cell-bearing oöspores, that the resting spores be tuberculately roughened or spiny.

In the Olpidiaceae, which in many respects runs parallel to the Woroninaceae in vegetative morphology, the genus *Olpidium* is well known as being cosmopolitanly parasitic, attacking higher plants, algae, other parasitic fungi, and even pollen grains. In typical members of the genus, however, a companion cell does not occur on the resting spore. A companion cell is, however, distinctive of *Pseudolpidiopsis,* and all the species of this genus are parasitic in green algae.

It is true, of course, that we have not definitely seen swarmspores and, being uncertain of their ciliation, cannot be sure even of the family to which our own and Carpenter's chytrids should

be assigned. But the definitely membrane-inclosed thallus, possible parasitism in higher plants, evidence of holocarpic copulation, and the presence of a characteristic companion cell, or male gametangium—characteristics both possess—seem to be fair characters upon which to base a tentative placement of the two chytrids in the Olpidiaceae, near *Pseudolpidiopsis*. Certainly the observed structures, and the processes to be inferred from them, eliminate any possibility of placing these chytrids in the Synchytriaceae or any of the more complex families of the Chytridiales.

Neither our chytrid nor Carpenter's can well be assigned to *Pseudolpidiopsis,* since both produce two well-defined forms of plasmodia, appear not to form resting spores in the same host cells occupied by the plasmodia (Carpenter's *figs. 6* and *7,* our FIGS. 4 and 14), give evidence of isothallic (Carpenter's *figs. 7* and *11,* our FIGS. 5–11) rather than anisothallic copulation, and seem to be mononucleate when fully encysted and possessed of companion cells (Carpenter's *fig. 11,* our FIGS. 4–11). That they are, nevertheless, so distinctive in appearance as to be not only readily recognized but also easily distinguished from all other chytrids, is equally clear. It seems desirable, therefore, to establish the following genus, ultimate placement of which must depend upon further discovery and interpretation of details as to life history and cytology.

Carpenterella gen. nov.

Mycelium none; thallus appearing in two forms, one amorphic and amoeboid in aspect, the other elongate, attenuate, and with bead-like swellings; parasitic within deep-seated parenchymatic and vascular elements. Resting spores resulting from holocarpic fusion of equal thalli, spherical, with thick, smooth, hyaline walls and dense to opaque protoplasts, possibly mononucleate. Companion cell present. Swarmspores (as yet) unknown.

Mycelium nullum; thallus in formis duabus visus, una non definita et amoeboidea, altera elongata, attenuata, et cum inflationibus rotundatis; ut parasitus in cellis intimis parenchymis et vascularibus vivens. Sporae perdurantes factae confusione holocarpe thallorum aequorum, sphaericales, cum muris densis, planis, hyalinis et protoplastibus densis usque opacis, probabiliter cum modo uno nucleo. Cella comes adest. Zoosporae usque ad huc incognitae.

Carpenterella Molinea sp. nov.

Amoeboid thalli variable in size and irregular in shape, highly vacuolated; attenuate thalli very fine and threadlike, about 1 μ thick, with few to many bead-like enlargements, 3–6 μ in diameter; inhabiting parenchyma, fiber and ray cells in xylem; resting spores spherical, when young 15–25 μ in diameter and thin walled, when mature about 10 μ in diameter, thick-walled and provided with a small companion cell.

Thallis amoeboideis variabilibus magnitudine et imparibus forma, cum vacuolis permultis; thallis attenuatis tenuissimis circa 1 μ densis, cum paucis usque multis inflationibus rotundatis 3–6 μ diam.; cellas parenchymas, fibras et radios in xylimine incolentibus; sporis perdurantibus sphaericalibus, juvenalibus 15–25 μ diam. et cum muris tenuibus, maturis circa 10 μ diam., cum muris densis et cum cella comite parva paratis.

Habitat: In xylem tissues of the Moline variety of *Ulmus americana* L.

Type material: Accession number *22,722* and accompanying microscopic slides in the Mycological Collection of the Illinois State Natural History Survey, collected by E. L. Chambers, Madison, Wisconsin, May 4, 1932.

There is no evidence, other than our purely negative failure to find any other organism by cultural trials and microscopic examination, to establish the elm chytrid as the cause of the disease with which it was associated. Its occurrence within the elm seems to have special interest, however, as tending to show that chytridiaceous organisms can invade tissues in the trunk and branches of woody plants and might possibly assume there the rôles of parasites or commensals. Perhaps most interesting is the apparent adaptation to such a rôle. Chytrids ordinarily parasitic in filamentous, thin walled plants customarily produce their resting spores in the cells they parasitize and depend, for the distribution of their swarmspores, upon exit tubes which pierce the retaining host wall; but here the resting cells are produced, not in the heavy-walled cells that are attacked but in tracheae where, with or without an exit tube, the swarmspores will not only be free at once but will also have at hand an excellent avenue of distribution to other parts of their host.

SECTION OF APPLIED BOTANY AND PLANT PATHOLOGY,
ILLINOIS STATE NATURAL HISTORY SURVEY,
URBANA, ILLINOIS

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EXPLANATION OF FIGURES

FIG. 1. Elm chytrid in elm wood, × 100; showing tracheae occluded by tyloses and containing deeply stained spherical bodies (above) and less deeply stained bodies (below) in pairs. FIGS. 2–3. Thalli in fiber cells, × 1000: 2, attenuate thallus with fusiform enlargement; 3, attenuate thallus with bead-like swellings. FIG. 4. Resting spores in the lumen of a trachea, × 1000, the lower with its vesicle in focus, and a wood parenchyma cell, at the left, with a thallus remnant visible. FIGS. 5–10. Stages in the formation of the oöspore, showing shrinkage of the male cell to form the companion cell of the oöspore. FIG. 11. Mature oöspore with dense, alveolar cytoplasm, granules, heavy wall, and companion cell. FIG. 12. Thalli in a fiber cell, showing plasmodial enlargements and bead-like knots. FIG. 13. Thallus in ray and wood parenchyma cells, showing connections through pits. FIG. 14. Net-like thallus in a parenchyma cell, sending plasmic projections into an adjoining trachea through half-bordered pits.

BIATORELLA RESINAE: THE PERFECT STAGE OF ZYTHIA RESINAE

Theodore T. Ayers [1]

The examination of numerous cankers, both of known and undetermined origin, showed that *Biatorella resinae* (Fries) Mudd, a small orange discomycete, was associated frequently with the light yellow pycnidial form, *Zythia resinae* (Ehrenb.) Karst., growing on excreted resin. The frequent association and the growth of these fructifications on the same unusual medium suggested that they were different stages in the life cycle of the same organism, instead of separate species.

As far as could be determined from available literature on *Biatorella resinae* and *Zythia resinae,* a connection between the two forms as representing the perfect and imperfect stages of the same organism had not been established by pure culture, although the possibility of a genetic connection between them had been advanced. As early as 1871 Fuckel (2) stated that *Biatorella resinae,* which he described as *Retinocylus flavus,* had a pycnidial stage which he called *Nectria resinae* Fries (*Zythia resinae*). More recently (1922), Overholts (7) suggested a relationship between them because they were growing together on " resin exudate inhabited by the larvae of the ' pitch midge ' on *Pinus virginiana* and *Pinus ponderosa.*" A few years later, Jørstad (3) also mentioned a genetical connection between these fructifications, writing " . . . I should, on the other hand, be inclined to believe that the respective pycnidia have belonged to the conidial stage, *Zythia resinae,* of the ascus fungus, *Biatorella resinae,* living upon resin. . . ." However, neither Overholts nor Jørstad presented data to support his conclusions.

Nannfeldt (5), however, mentioned no genetical connection between *Biatorella resinae* or *Tromera resinae* and *Zythia resinae* in his discussion of this discomycete. Likewise, Clements and Shear

[1] Formerly Agent, Division of Forest Pathology, Bureau of Plant Industry, United States Department of Agriculture and stationed at New Haven, Conn.

(1) illustrated both *Biatorella resinae* (Plate 27) and *Zythia resinae* (Plate 50) and treated them as separate fungi.

With fresh apothecia of *Biatorella resinae* and pycnidia of *Zythia resinae* available, an opportunity arose to determine by pure cultures whether these two fungi were different stages in the life cycle of the same organism or two distinct entities. The results of these culture experiments, together with the geographical distribution of the hosts upon which the fungus has been found during this study, are presented in this paper.

CULTURE EXPERIMENTS WITH BIATORELLA RESINAE AND ZYTHIA RESINAE

To demonstrate by pure cultures that *Biatorella resinae* and *Zythia resinae* are the ascigerous and pycnidial stages, respectively, of the same fungus, single-spore isolations were made at different times from the two types of fructifications, which had been collected from various sources. Single spores were isolated from a pycnidium or apothecium which was sufficiently removed from the other type of fruiting body to insure obtaining only the spore desired.

During this investigation, 90 single-ascospore isolates of *Biatorella resinae* were made from apothecia growing on various hosts from different localities (Table 1). The ascospores germinated usually within 24 hours at room temperature on plates of 3 per cent commercial malt agar or synthetic malt agar (4, formula No. 1579) and produced colonies large enough to isolate by means of a 20 $\times$ ocular dissecting microscope within 3 or 4 days. These isolates were planted on either commercial or synthetic malt agar. Upon these substrata, the fungus formed colonies which were appressed and white at first, but later changed to a light-yellow color. Although some colonies produced a few tufts of white, aerial mycelium at their centers, in all cases the cultural characteristics were essentially identical. The colonies grown from single ascospores produced within a month, and usually on both types of malt media, light-yellow to amber-colored pycnidia. These fruiting bodies were identical with those produced by *Zythia resinae* in nature on different conifers and in artificial media. The pycnidia formed by the fungus on these artificial media usually excreted

large masses of viable conidia, similar to those produced in the pycnidia of *Zythia resinae* under natural conditions.

TABLE 1

NUMBER OF SINGLE-ASCOSPORE AND SINGLE-CONIDIAL ISOLATES FROM DIFFERENT COLLECTIONS

F. P.[a] Number	Host	Source	Single-ascospore isolates	Single-conidial isolates
53900	*Chamaecyparis thyoides* (L.) B.S.P.	Walpole, Mass. May 14, 1933	12	—
69696	*Larix leptolepis* Murr.	Ipswich, Me. February 11, 1935	—	—
53903	*Picea rubra* (DuRoi) Dietr.	Perry, Me. May 4, 1933	10	—
64081	*Pinus echinata* Mill.	Russelville, Ark. 1933	10	10
53904	*Pinus flexilis* James	Hamilton, Mass. May 22, 1933	9	10
64076	*Pinus rigida* Mill.	Bloomfield, Conn. Nov. 27, 1932	9	—
53848	*Pinus strobus* L.	Bar Harbor, Me. September 29, 1932	6	—
64064	*Pinus strobus*	Winthrop, Me. November 8, 1933	25	—
53902	*Pinus taeda* L.	Shenandoah, W. Va. June 12, 1933	9	—

[a] These collections are filed in the herbarium of the Division of Forest Pathology, United States Department of Agriculture, New Haven, Conn.

Conidia of *Zythia resinae* were then used to determine by pure culture methods its genetical relationship to the ascomycete, *Biatorella resinae*. At different times, a total of 30 single-conidial isolates were made from various sources (Table 1). The colonies produced by these isolates on 3 per cent commercial malt extract and on synthetic malt media corresponded closely to those obtained from the single-ascospore isolates. These colonies produced fertile pycnidia identical with those produced by the single-ascospore isolates from *Biatorella resinae*.

Pycnidia readily formed in cultures started either from single ascospores or from single conidia, but apothecia of *Biatorella resinae* were never observed in artificial cultures originating from either type of spore. Apothecia, furthermore, were never formed in cultures isolated from inner bark of the host where probably the elements necessary to apothecial formation are present. De-

spite the lack of formation of the apothecial stage of this fungus in artificial culture, the similarity of cultural characteristics and the production of the same pycnidial stage in the cultures, originating either from single ascospores of *Biatorella resinae* or from single conidia of *Zythia resinae,* prove that these two different fructifications represent the ascigerous and pycnidial stages in the life history of the same organism and not two distinct species of fungi.

SOME UNREPORTED HOSTS FOR BIATORELLA RESINAE IN THE UNITED STATES

Although *Biatorella resinae* was found frequently during this investigation to be associated with cankers on a number of different hosts, an examination of Seymour's (8) Host index of North American fungi showed that this fungus had been reported previously for the United States upon *Pinus strobus, Abies* sp. and *Pinus* sp. (*Zythia* stage) only. Besides these hosts, Overholts (7) stated that it was present on two- and three-needled pines. As representatives of these groups, he cited *Pinus ponderosa* and *P. virginiana.* In contrast to this limited host range in North America, *B. resinae* has been listed in Europe (6) on a wide range of coniferous species.

In addition to its occurrence upon the tree species reported by Seymour and Overholts in the United States, *Biatorella resinae* and its imperfect stage *Zythia resinae* have been collected on several different species of trees during this study. The hosts upon which this fungus has been found and their distribution according to States are grouped together in the following list:

On Abieteae. *Larix laricina* (DuRoi) Koch.—Conn.; *L. leptolepis*—Mass.; *Picea glauca* (Moensch) Voss—N. Y.; *P. rubra*—Me.; *P. pungens* Engelm.—Mass.; *Pinus echinata*—Ark., Ohio; *P. flexilis*—Mass.; *P. ponderosa*—Pa.; *P. rigida*—Conn., Pa.; *P. strobus*—Me., R. I.; *P. sylvestris* L.—Me., Mass.; *P. taeda*—Del., W. Va.; *P. virginiana* Mill.—Pa.

On Cupresseae. *Chamaecyparis thyoides*—Mass.

INFECTION TESTS WITH BIATORELLA RESINAE ON PINUS STROBUS

Because the apothecia and pycnidia of *Biatorella resinae* are associated frequently with cankers on different conifers, and since

the pycnidia appeared frequently in tissue cultures, a preliminary test was made to determine whether *B. resinae* is parasitic. Accordingly, six inoculation tests were made by inserting portions of a pure culture of this fungus in wounds on small branches of a thrifty eastern white pine (*Pinus strobus*) in a greenhouse at New Haven, Conn. On the same tree checks were made simultaneously in a similar manner but with sterile agar.

Under observation for four years, these inoculations never showed during this period that *Biatorella resinae* can parasitize eastern white pine on which it is frequently found. Because of the limited number of inoculations and since only one strain of the fungus was used, it is impossible to conclude at this time whether *Biatorella resinae* is parasitic or saprophytic on this host.

SUMMARY

Biatorella resinae, a discomycete, was demonstrated to be the ascigerous stage of the pycnidial form, *Zythia resinae,* by means of single-ascospore and single-conidial cultures.

The hosts upon which the apothecial and pycnidial stages of *Biatorella resinae* have been collected during this study and their geographical distribution are reported herein.

Inoculation tests with artificial cultures of *Biatorella resinae* on *Pinus strobus* failed to show that this fungus was parasitic on the conifer.

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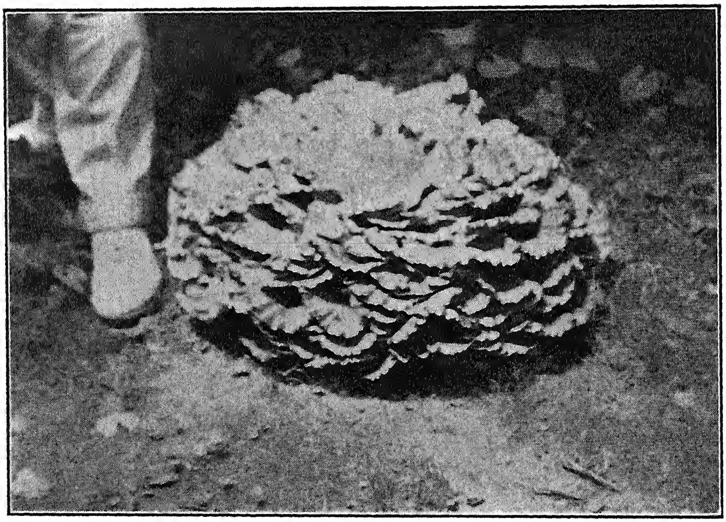
NOTES AND BRIEF ARTICLES

A LARGE FRUCTIFICATION OF POLYPORUS SULPHUREUS

The sulphur fungus, *Polyporus sulphureus* (Bull.) Fries, causes a cubical brown rot of hardwoods and commonly forms conspicuous imbricated fruiting bodies near the base of standing trees or



Polyporus sulphureus.

on stumps. In early July, 1940, a fructification of this fungus was observed to be forming on an oak root in the yard of Mrs. R. L. Montgomery, Durham, N. C. This fructification attained maturity after nearly three weeks, and was then approximately 40 cm. high and 70 cm. across. It was centrally attached and roughly hemispherical in outline. The largest pilei were near the base, and they became progressively smaller toward the top. The accompanying photograph by Exie Duncan shows these features and the comparative size of the fruit-body.

In direct sunlight it was noticed that a cloud of spores invested

the fruiting body. The spores were shed in such profusion that they formed a conspicuous white deposit on the surrounding vegetation and soil, and on the upper surface of the pilei.

It would be interesting to know how fungi metabolize and store sufficient food to make possible the production of such large fructifications in so short a period of time.—FREDERICK A. WOLF.

USE OF DICHLORICIDE IN THE CONTROL OF SCAVENGER MITES IN TEST TUBE CULTURES

Experiments have shown that scavenger mites can be readily killed in test tubes containing cultures of fungi without evident injury to the fungi. Baskets of contaminated tubes and about 1/4 ounce dichloricide crystals in a watch glass were placed under a stoppered bell jar which was sealed with vaseline to a glass table top. It was allowed to remain about an hour to permit evolution of gas. By alternately exhausting air and releasing negative pressure a few times gas was drawn into the test tubes. On removing the bell jar and examining the tubes the next morning no living mite was observed. About 200 species of fungi in all classes were treated with no apparent injury to any.

In another experiment, a crystal of dichloricide was placed between the cotton plugs and walls of several tubes containing fungus cultures contaminated by scavenger mites and left in the laboratory. No living mite was observed the following morning. A week later transfers were made from these tubes and the fungi grew in the same manner as transfers of subcultures of the same fungi which were not treated with dichloricide. In a further experiment a transfer of each of several fungi was made to potato dextrose agar, and to potato dextrose agar on which a crystal of dichloricide was placed at the time of making the transfer. All fungi grew apparently normally.—IVAN H. CROWELL.

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GEASTER LIMBATUS: A NEW VARIETY

ELIZABETH EATON MORSE

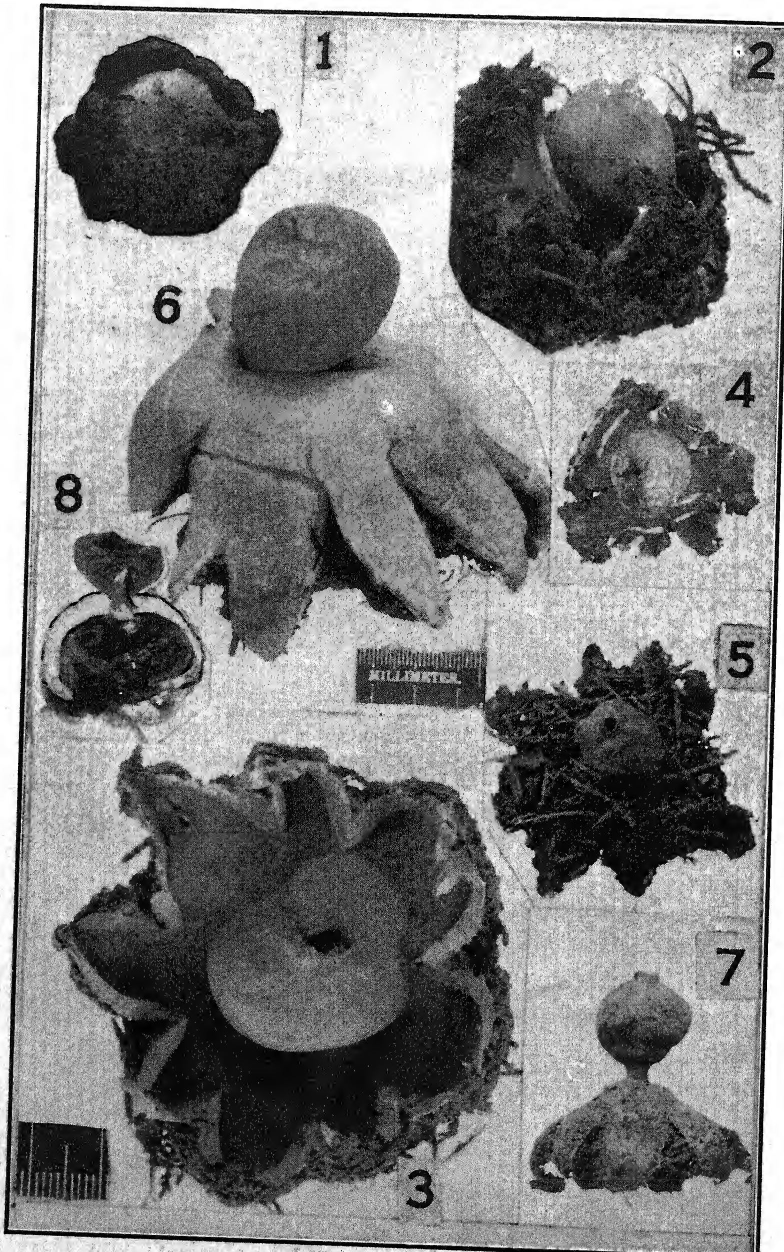
(WITH 8 FIGURES)

A colony of large earthstars was found growing from abundant matted mycelium under a juniper hedge in Berkeley, California, after the heavy autumn rains in 1933. The first collection consisted of eighteen specimens, in each of which there was a violet-pinkish coloration in the fleshy layer next to the spore sac. This coloration suggested *Geaster rufescens* but there were several characters in this material which did not conform to the descriptions of that species. We submitted specimens to Doctor W. C. Coker, who returned the determination *G. limbatus,* also he very kindly forwarded a specimen of what he believes is typical *G. rufescens* which grew in Chapel Hill, North Carolina. Basing judgment on this specimen our geasters plainly were not *G. rufescens.* In fact the spores resembled, rather, those of *G. limbatus,* but no record of a pinkish coloration in the fleshy layer of that species could be found. Since this western material is not *G. rufescens,* macroscopically or microscopically, and since it resembles *G. limbatus* microscopically, it seems advisable to describe it as a variety of the latter.

Geaster limbatus Fries var. **pacificus** var. nov.

Fungus immaturus globoso-depressus; fungus maturus laciniis patentibus usque ad 10 cm. latus; exoperidio sordibus vestito; strato carnoso crasso, fragili, puniceo-tincto. Columella immaturitate percurrens.

[MYCOLOGIA for January–February (**33**: 1–137) was issued February 1, 1941]



FIGS. 1–8. *Geaster limbatus* var. *pacificus.*

Button globose flattened, not at all pointed, entirely submerged; outer mycelial layer flaky and pliable, holding firmly a thick mass of soil and trash, may separate from the middle fleshy layer. Expanded, the fleshy layer is smooth, brittle when fresh, not pitted or spongy, up to 4 mm. thick, with a pinkish coloration in the exposed surface, this coloring fading or quite disappearing in wet weather; fleshy layer when dried very thin, about one-half mm. thick, reddish brown; inner peridium (spore sac) with definite stout stalk, up to 5 mm. thick and 3–4 mm. long, not showing in the fresh plant until the segments roll back; spore sac 1.5–3 cm. thick, subspherical, pale gray when fresh, later may become dark brown depending on the weather and the number of spores held on the surface; definite apophysis usually in evidence; mouth when fresh rather definite, more silky shining than the case and surrounded by a shallow groove, later becomes elevated, fimbriate and indefinite. Center of outer peridium always arched on under side, but rays very variable in position—much cupped around the spore sac, or nearly plane, or well reflexed, according to the amount of moisture present while maturing. Columella percurrent in early stage, definite, may extend when mature one-third way into the glebal chamber. Spores purplish brown, spherical, strongly warted when mature, 4–5.5 μ, capillitium up to 7 μ thick.

The variety differs from what is regarded as typical *G. limbatus* in its larger size, the much more trashy outer layer which may separate from the fleshy layer, the pinkish coloration of the fleshy layer, and also the more pronounced stalk and less elongated tips of the rays. It differs from *G. rufescens* in its longer stalk, much thinner and not spongy fleshy layer when dry, the more firmly adhering outer mycelial layer, and the rougher spores which are less deeply colored *en masse*. The correspondence of spores with *G. limbatus* rather than with *G. rufescens*, the pronounced columella, and the pinkish coloration in fleshy layer are three outstanding characters of the variety.

Aside from the type collection, University Calif. Herb. No. *506573*, specimens have been collected since 1933 in the same limited area, also under geraniums which border the adjacent sidewalk. A single specimen was collected in soil under a small tree on University of California Campus near Life Sciences Building (Morse, March 8, 1936); also, under *Chamaecyparis Lawsoniana*, Hotel Claremont garden, Berkeley (Morse, Spring, 1938, 1939).

The largest specimen we have (10 cm.) grew under an *Adenostoma fasiculatum* on steep west-facing canyon slope, south of Nortonville, Contra Costa Co. (Lee, Jan. 12, 1936). A collection was made in duff under *Aesculus* and *Umbellularia,* Hotel Rafael, San Rafael, Marin Co. (L. Bonar, Nov. 28, 1937); Regional Park, Wild Cat Canyon (M. Spurrier, 1938); another collection, buried in leaf mold in oak woods, Rocky Nook Park, Santa Barbara (P. M. Rea, March 10, 1939). Recent collections: in black soil on thin *Umbellularia* duff, gregarious, Wild Cat Canyon, Contra Costa Co. (Robert Y. Wing, Jan. 4, 1939; Feb. 11, 1940); on *Acacia* duff, south of Boalt Hall, U. C. Campus, Berkeley (V. Ranzoni, Nov. 1, 1940).

I am indebted in this study to F. J. Seaver who kindly sent material from the New York Botanical Garden; to W. C. Coker and Alma Holland, University of North Carolina; to John Dearness, Canada; to Carleton Rea, England; to Lee Bonar and Vera M. Miller, University of California.

CALIFORNIA MYCOLOGICAL SOCIETY,
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BERKELEY, Dec. 1, 1940

EXPLANATION OF FIGURES

FIGS. 1–8. Photographs by W. C. Matthews. *Geaster limbatus* var. *pacificus:* 1, early stage, button cracked on one side, shows a smooth, grayish spore sac; tips of blunt rays not extended; 2, spore sac emerging from exoperidium which is loaded with soil and juniper trash; peristome elevated, fibrillose, surrounded by pallid silky zone; 3, expanding rays split half way, cupped about the spore sac, showing marked difference in coloration of exposed surface and flesh beneath; tips of rays at this stage often inrolled; 4, fleshy layer cracked shows white flesh beneath. Mouth silky fibrillose; 5, button submerged but close to surface of juniper duff, expanded after heavy rains; nine segments may be distinguished, spore sac elevated above the trash; mouth determinate (young) showing definite ridge; 6, fresh young specimen, rays turned back, fleshy layer thick, brittle; pale pinkish coloration in exposed surface; spore sac not yet elevated, pedicel not yet in view; 7, fully mature, spore sac elevated, mouth now indeterminate, distinct apophysis, pedicel laterally compressed; fleshy layer shrunken to one-half mm.; exoperidium still loaded with trash; 8, vertical median section, conical columella extends one third the way into glebal chamber; extensive mycelial layer still intact, not at all fornicate; in typical *G. limbatus* the columella is "obsolete" (Cleland) or small and "knob-like" (Coker).

Note: Figs. 1, 2, 3, 6, cm. scale; 4, 5, 7, 8, mm. scale.

UREDINALES OF NEW GUINEA[1]—III

George B. Cummins[2]

(with 7 figures)

The 54 species of Uredinales reported in this paper were collected by Mrs. Mary Strong Clemens in Morobe District, New Guinea. Of the 54 species one is transferred as a new combination and 12 are described as new species. The type specimens are deposited in the Arthur Herbarium, Purdue University Agricultural Experiment Station.

Pucciniastrum Boehmeriae (Dietel) Sydow.

On *Boehmeria* sp., Sattelberg, Oct. 9, 1935 (*339*); above Kajabit, Jan. 4, 1939 (*10921*); Ogao to Samanzing, June 26, 1939 (*10280*); Samanzing to Milulunga, July 5, 1939 (*10434*).

Coleosporium Merrillii P. Henn.

On Orchidaceae, Wareo, Jan. 3, 1936 (*1486*).

Phakopsora Oplismeni (Arth. & Cumm.) comb. nov. (*Uredo Oplismeni* Arth. & Cumm. Phil. Jour. Sci. **59**: 442. 1936) (fig. 2).

Telia hypophyllous, subepidermal, oval or elongate, 0.1–0.15 × 0.3–1.0 mm., golden-brown, darkening with age, compact, waxy in appearance, not remaining covered by the epidermis, 3–8 spores thick, the upper layers collapsing after germination, not firmly united, irregularly arranged; teliospores ellipsoid, oblong or cuboid, 9–16 × 14–23 μ; wall hyaline or yellowish, smooth, 0.5–1 μ thick; germinating at once.

On *Oplismenus compositus* (L.) Beauv., Kajabit Mission, Aug. 12, 1939 (*10568*).

[1] Contribution from the Department of Botany, Purdue University Agricultural Experiment Station, Lafayette, Indiana.

The second article of this series was published in Mycologia **33**: 64–68. 1941.

[2] I am indebted to Drs. E. D. Merrill and J. R. Swallen for giving opinions concerning the identity of some of the hosts.

PHAKOPSORA PACHYRHIZI Sydow.
On *Mucuna* ? sp., Kajabit Mission, Sept. 26, 1939 (*10707*).

CEROTELIUM DESMIUM (Berk. & Br.) Arth.
On *Gossypium* sp., Kajabit Mission, Nov. 23, 1939 (*10827*).

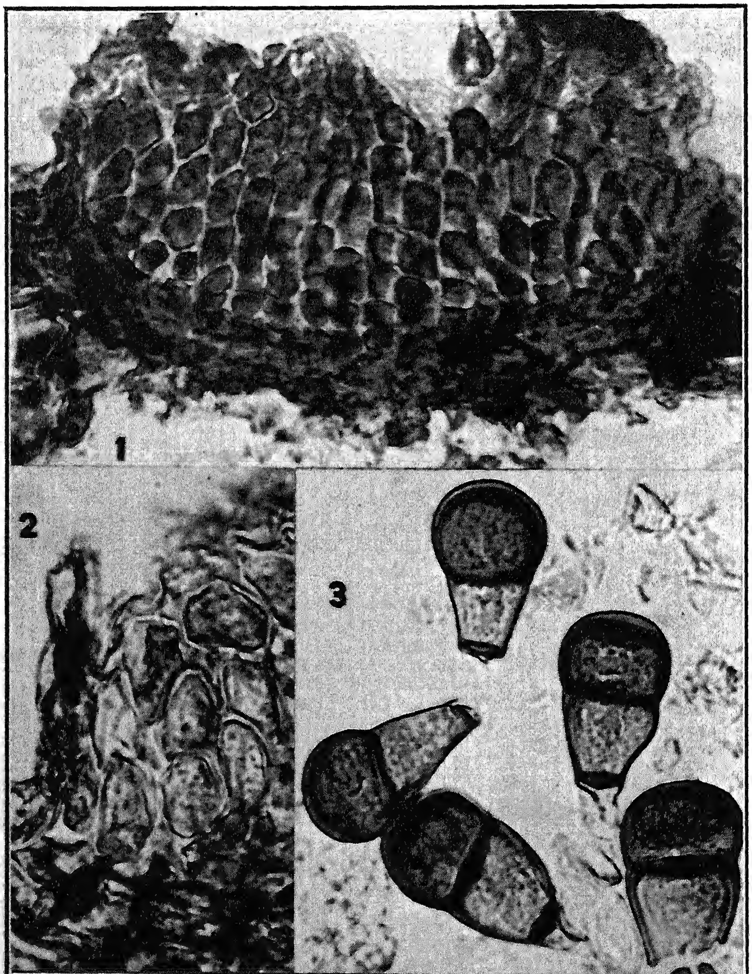

FIG. 1, free-hand, slightly stained section of a telium of *Cerotelium morobeanum* on *Derris;* 2, free-hand, slightly stained section of the marginal portion of a telium of *Phakopsora Oplismeni* on *Oplismenus;* 3, teliospores of *Puccinia Digitariae* on *Digitaria* (× 800).

Cerotelium morobeanum sp. nov. (FIG. 1).

Uredia hypophylla, subepidermalia, laxe aggregata, rotundata, minuta, 75–130 μ diam.; periphysibus inferne conjunctis, hyalinis, inconspicuis; urediosporae ellipsoideae vel obovoideae, 16–20 × 20–26 μ; membrana flavidula vel pallide brunnea, 1.5 μ cr., minuteque echinulata; poris germ. obscuris. Telia hypophylla, laxe aggregata, rotundata, 75–100 μ diam., compacta, aureo-brunnea; teliosporae oblongae, 6–8 × 10–15 μ; membrana hyalina, 0.5–1 μ cr.

On *Derris* sp., Kajabit Mission, Aug. 16, 1939 (*10581*, type), Sept. 8, 1939 (*10674*).

CROSSOPSORA ANTIDESMAE-DIOICAE (Racib.) Arth. & Cumm.

On *Antidesma ghaesembella* Gaertn., Kajabit Mission, Oct. 21, 1939 (*10794*).

GOPLANA DIOSCOREAE (Berk. & Br.) Cumm.

On *Dioscorea* sp., Salamaua, May 27, 1936 (*3176*).

ACHROTELIUM ICHNOCARPI Sydow.

On *Ichnocarpus* sp., Finschhafen, Sept. 3, 1935 (*50*); Kajabit Mission, Sept. 8, 1939 (*10673 bis*).

Skierka Clemensiae sp. nov. (FIG. 4).

Uredia amphigena, aggregata in maculis 0.5–2.0 mm. diam., subepidermalia, poro aperta, 0.1–0.25 mm. diam.; urediosporae ellipsoideae, obovoideae vel plus minusve fusoideae, 10–15(–17) × (20–)23–30(–33) μ; membrana hyalina, 1.5 μ cr., moderate echinulata; poris germ. obscuris. Telia adhuc ignota.

On *Canarium* sp., Kajabit Mission, Aug. 31, 1939 (*10629*).

Skierka Clemensiae differs from *S. philippinensis* Mains in having smaller urediospores with walls of uniform thickness. The echinulation is more uniformly distributed with no marked tendency toward longitudinal arrangement.

UROMYCES LEPTODERMUS Sydow.

On *Ischaemum* sp., Wareo, Jan. 11, 1936 (*1603*). On *Setaria geniculata* (Lam.) Beauv., Samanzing, Dec. 6, 1938 (*10417*A); Wantoat, Jan. 10, 1940 (*10948*). On *Setaria palmifolia* (Willd.) Stapf., Wantoat, Jan. 7, 1940 (*10939*).

UROMYCES PEGLERIAE Pole Evans.

On *Digitaria violascens* Link, Ogao, June 20, 1939 (*10359*).

UROMYCES APLUDAE Sydow & Butler.

On *Apluda mutica* L., Kajabit Mission, Aug. 31, 1939 (*10631*); Wantoat, Jan. 10, 1940 (*10949*).

UROMYCES PYRIFORMIS Cooke.

On *Acorus calamus*, L., Kajabit Mission, Aug. 22, 1939 (*10598*).

UROMYCES COMMELINAE Cooke.

On *Commelina* cf. *benghalensis*, Finschhafen, Sept. 9, 1935 (*87*). On undet. Commelinaceae, Sattelberg, Sept. 26, 1935 (*226*).

PUCCINIA POGONATHERI Petch.

On *Pogonatherum paniceum* (Lam.) Hack., Sattelberg, Oct. 4, 1935 (*318*), Oct. 1935 (*332b*); Wantoat, Jan. 13, 1940 (*10979*).

PUCCINIA RUFIPES Dietel.

On *Imperata cylindrica* (L.) Beauv., Heldsbach, Sept. 9, 1935 (*88*); Kajabit Mission, Sept. 8, 1939 (*10668*); Sept. 18, 1939 (*s. n.*). On *Imperata* sp., Wantoat, Jan. 12, 1940 (*11007a*).

PUCCINIA CITRATA Sydow.

On *Cymbopogon citratus* (DC.) Stapf., Wareo, Feb. 5, 1936 (*1818*); Sattelberg, Feb. 28, 1936 (*1910*); Quembung, Mar. 27–28, 1936 (*s. n.*); Yoangen, June 18, 1936 (*s. n.*); Malalo Mission and Salamaua, May 23–24, 1936 (*3160*).

PUCCINIA SORGHI Schw.

On *Zea Mays* L., Yunzaing, July 20, 1936 (*3666*).

PUCCINIA AIRIAE (Lagerh.) Cruchet & Mayor.

On *Deschampsia Klossii* Ridl., vicinity of Samanzing, Dec. 30, 1938 (*9441; 10326J*).

A few small epiphyllous, subepidermal, aparaphysate telia with clavate teliospores measuring 17–23 $\times$ 36–48 μ were found in this material and agree with the description published by Cruchet and Mayor. The paraphysate uredia also correspond.

PUCCINIA POAE-SUDETICAE (Westend.) Jørstad.

On *Anthoxanthum Horsfieldii* (Kunth) Mez, Mt. Sarawaket, Apr. 14, 1939 (*10132*), June 8, 1939 (*10231*). On *Poa longiramea* Hitchc., Mt. Sarawaket, Apr. 12, 1937 (*6147*), Apr. 14, 1939 (*10133*), June 15, 1939 (*10238a*), Feb. 21, 1939 (*9870*);

vicinity of Samanzing, Dec. 10, 1938 (*9439*), Dec. 11, 1939 (*10323B*), Dec. 1939 (*10469H*).

Only uredia are present in these collections.

PUCCINIA PYGMAEA Erikss.

On *Calamagrostis Brassii* Hitchc., Mt. Sarawaket, June 15, 1939 (*10238*).

This rather meager specimen has only uredia but the urediospores and paraphyses indicate *P. pygmaea.*

PUCCINIA RUBIGO-VERA (DC.) Wint.

On *Brachypodium longisetum* Hitchc., Upper Camp A, Mt. Sarawaket, Mar. 11, 1939 (*10016; 10017*), Apr. 6, 1939 (*s. n.*).

A few teliospores of the size and shape of those of *P. rubigo-vera* were seen but mature telia are not present.

PUCCINIA ORIENTALIS (Sydow & Butler) Arth. & Cumm.

On *Panicum* sp., Malalo Mission, Salamaua, May 23, 1936 (*3161A*).

PUCCINIA CYNODONTIS Lacroix.

On *Cynodon dactylon* (L.) Pers., Sambanga, Nov. 2, 1937 (*7483*).

PUCCINIA LEVIS (Sacc. & Bizz.) Magn.

On *Digitaria pruriens* (Fisch.) Buse, Kajabit Mission, Aug. 30, 1939 (*10630*).

PUCCINIA DIGITARIAE Pole Evans (FIG. 3).

On *Digitaria pertenuis* Buse, Wareo, Feb. 4, 1936 (*1835*); Wantoat, Jan. 10, 1940 (*10947C*). On *Digitaria pruriens* (Fisch.) Buse, Kajabit Mission, Aug. 30, 1938 (*10630A*), Kajabit Mission, Markham Valley, Sept. 18, 1939 (*s. n.*). On *Digitaria* sp., Wantoat, Jan. 12, 1940 (*10971*).

P. Digitariae is described as having four equatorial pores but in these collections the pores, while commonly four, vary from four to six. The uredia have paraphyses as described and the telia and teliospores, present only in the Markham Valley collection, are characteristic.

PUCCINIA PAULULA Sydow.

On *Alocasia* ? sp., Kajabit Mission, Oct. 20, 1939 (*10786*).

The sori of this rust are nearly extrastomatal in development but the spores, borne on simple pedicels, are initiated subepidermally. *P. paulula* was described from the Philippines on *Amorphophallus campanulatus.* Through the kindness of Dr. D. H. Linder I was enabled to compare the Philippine and New Guinea specimens. No substantial difference exists.

PUCCINIA EXHAUSTA Dietel.

On *Clematis* sp., Kajabit Mission, Sept. 8, 1939 (*10658*), Oct. 20, 1939 (*10779B*).

Puccinia eluta sp. nov. (FIG. 5).

Pycnia epiphylla, subepidermalia, paraphysata, 100–175 µ diam. Aecia hypophylla vel petiolicola, in maculis leniter incrassatulis rotundatis vel elongatis usque ad 10 mm. longis aggregata, cupulata, 0.2–0.3 mm. diam., flavida; cellulis peridii ellipsoideis vel oblongis, 25–35 × 35–60 µ, pariete interiore verrucoso 3 µ cr., exteriore 2 µ cr. levi; aeciosporae ellipsoideae vel oblongo-ellipsoideae, 19–28 × 32–53 µ; membrana pallide flavida, 1.5–2 µ cr., ad apicem 2–10 µ cr., moderate et denseque verrucosa. Uredia nulla. Telia hypophylla, subepidermalia, rotundata, 0.1–0.2 mm. diam., in greges 1–2 mm. diam. disposita, flavida; teliosporae ellipsoideae, utrinque rotundatae, medio constrictae, 24–29 × 38–48 µ; membrana 1.5 µ cr., pallide flavida, levi; pedicello hyalino, sporam breviore.

On *Deeringa* sp., Sattelberg, Jan. 19, 1935 (*1265*); Wantoat, Jan. 7, 1940 (*10930,* type).

In gross appearance the aecia of *P. eluta* are similar to those of *P. calosperma* Sydow but the aeciospores are larger. The smooth pale teliospores are entirely different from the teliospores of *P. calosperma.*

PUCCINIA ENGLERIANA P. Henn.

On *Tabernaemontana* sp., Kajabit Mission, Sept. 15, 1939 (*10694*).

Puccinia morobensis sp. nov. (FIG. 6).

Pycnia amphigena, subepidermalia, globoidea, 125–175 µ diam. Aecia amphigena, subepidermalia, rotundata, 0.3–0.4 mm. diam., aperidiata, in maculis aureis usque 8 mm. diam. aggregata; aeciosporae ellipsoideae, oblongo-ellipsoideae vel obovoideae, 23–32 × 32–46 µ; membrana hyalina vel pallide flavida 3–6 µ cr., moderate aculeata, ad apicem et basim 5–12 µ et plus

minusve levi. Uredia hypophylla, sparsa vel laxe aggregata, cinnamomea, 0.1–0.3 mm. diam.; urediosporae late ellipsoideae vel obovoideae, 23–28 × 29–35 μ; membrana pallide cinnamomea 1.5 μ cr., moderate echinulata; poris germ. 2, aequatorialibus. Telia uredia conformibus; teliosporae ellipsoideae vel oblongo-ellipsoideae, utrinque rotundatae, medio constrictae, 24–29 × 33–45 μ; membrana pallide castanea vel aurea, 1.5 μ cr., minuteque echinulata vel apparenter levi; poro superiore apicali, inferiore medium loculum sito;

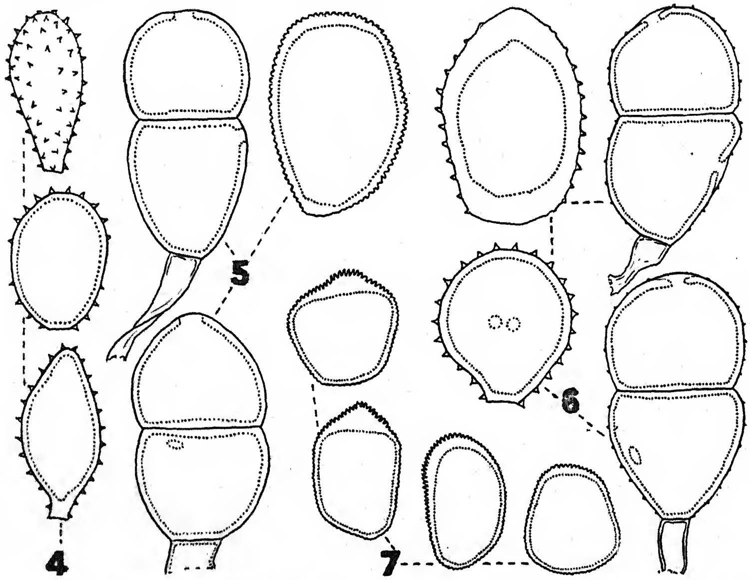

FIG. 4, three urediospores of *Skierka Clemensiae* on *Canarium;* 5, two teliospores and one aeciospore of *Puccinia eluta* on *Deeringa;* 6, one aeciospore, one urediospore and two teliospores of *Puccinia morobensis* on *Tabernaemontana;* 7, four aeciospores of *Aecidium papuanum* on *Blumea* (× 650).

pedicello hyalino, fragili, brevi.

On *Tabernaemontana* sp., Sattelberg to Quembung, Nov. 26, 1935 (*1017a*).

This rust, because of the aculeate aeciospores, differs from both *P. Engleriana* P. Henn. and *P. Tabernaemontanae* Berk. & Br. The teliospores are similar to those described for *P. Tabernaemontanae* but the urediospores are significantly smaller.

PUCCINIA THWAITESII Berk.

On *Justicia Gendarussa* Burm. f., Kajabit Mission, Aug. 9, 1939 (*10563*), Nov. 12–14, 1939 (*10820*); Wantoat, Jan. 8, 1940 (*s. n.*):

PUCCINIA FALLAX Arth.

On *Psychotria* sp., Bandong, mts. above Boana, July 4, 1938 (*8435*); Kajabit Mission, Aug. 31, 1939 (*10632*).

I can detect no differences between the urediospores and teliospores of these collections and American material of the species. Previous telial collections have been on *Palicouria,* with only uredia known on *Psychotria. P. Palicouriae* Mains is a similar rust but has more strongly echinulate urediospores.

ENDOPHYLLUM EMASCULATUM Arth. & Cumm.

On *Breynia* sp., Sattelberg, Nov. 2, 1935 (*s. n.*); Quembung Mission, Mar. 23, 1936 (*2150*); Samanzing, July 5, 1939 (*s. n.*); Wantoat, Jan. 15, 1940 (*10990bis*).

This is a rust of uncertain relationship. The compact nature of the sori indicates a strong lateral adherence of the spores. Freehand sectioning may separate the sorus from the host but the spore mass remains intact even in thin sections. The species is undoubtedly microcyclic, although germination has not been observed, and perhaps is near the relatively obscure genus *Dietelia.*

UREDO ARTHRAXONIS-CILIARIS P. Henn.

On *Arthraxon hispidus* (Thunb.) Merr., Heldsbach, Oct. 1935 (*s. n.*); *Sattelberg,* Feb. 28, 1936 (*s. n.*); Ogao, June 20, 1938 (*s. n.*).

UREDO POLLINIAE-IMBERBIS S. Ito.

On *Eulalia ciliata* (Trin.) Kuntze, Boana, May 2, 1938 (*8150*).

This collection is meager and can be referred only tentatively to *U. Polliniae-imberbis.* The species may belong in *Angiopsora* or *Phakopsora.*

Uredia hypophyllous, golden, with peripheral incurved paraphyses united below, 9–15 × 35–50 μ, the wall 1.5–4 μ thick on the outer side and at the apex, thin on the inner side; urediospores obovoid or broadly ellipsoid, 18–20 × 23–28 μ, the wall hyaline or yellowish; finely and closely echinulate, the pores obscure.

Uredo ogaoensis sp. nov.

Urediis hypophyllis, rotundatis vel ovatis, 0.1–0.3 mm. longis, brunneis, maculis purpureo-brunneis occupantibus; paraphysibus copiosis, capitatis, 13–19 × 35–50 μ; membrana flavida, 1.5–2 μ cr., ad apicem 3–8 μ; urediosporae ellipsoideae vel ovoideae, 15–22 × 19–24(–26) μ; membrana obscure cinnamomea, 1–1.5 μ cr., minuteque echinulata; poris germ. 4, aequatorialibus.

On *Microstegium nudum* (Trin.) Camus, Ogao to Samanzing, June 26, 1939 (*10279,* type); Samanzing, June 28, 1939 (*10380*).

The sori of *U. ogaoensis* are similar to the uredia of *Puccinia aestivalis* Dietel, judging from the description, but the urediospores of *U. ogaoensis* are smaller and darker colored.

Uredo themedicola sp. nov.

Urediis hypophyllis, oblongis, 0.2–0.6 mm. longis, sparsis vel seriatim dispositis, pallide cinnamomeis; urediosporae globoideae, 19–23 × 21–26 μ; membrana aureo- vel cinnamomeo-brunnea, 1.5–2 μ cr., minuteque echinulata; poris germ. 6–8, sparsis.

On *Themeda triandra* Forsk., Markham Valley, Kajabit Mission, Aug. 31, 1939 (*10633B*).

This rust differs from *Uredo Themedae* Dietel, and *Puccinia burmanica* Sydow & Butler, in having echinulate urediospores.

UREDO GENICULATA Cumm.

On *Sorghum nitidum* (Vahl) Pers. (*Andropogon serratus* Thunb.), Kajabit Mission, Sept. 8, 1939 (*10665*).

UREDO PASPALINA Sydow.

On *Paspalum cartilagineum* Presl, Wareo, Dec. 31, 1935 (*1413*); Sattelberg, Mar. 10, 1936 (*2004*); Lae vicinity, July 15, 1939 (*s. n.*). On *Paspalum longifolium* Roxb., Kajabit Mission, Sept. 27, 1939 (*10706*), Oct. 18, 1939 (*10787*).

Uredo Palmifoliae sp. nov.

Urediis amphigenis vel praecique hypophyllis, minutis, in maculis brunneis elongatis sparsis dispositis; paraphysibus periphericis copiosis, incurvatis, cylindraceis; membrana hyalina vel pallide flavida, pariete interiore 1.5–2 μ cr., exteriore 3–6 μ cr.; urediosporae obovoideae, ellipsoideae vel late ellipsoideae, 17–20 × 21–27 (–29) μ; membrana flavida 1–1.5 μ cr., minuteque echinulata; poris germ. obscuris.

On *Setaria palmifolia* (Willd.) Stapf., Sattelberg, Mar. 13, 1936 (*2958,* type), May 7, 1936 (*3069*).

Mrs. Clemens describes this rust as "golden" but in the dried condition it is brownish. The uredia have the characteristics of those of *Angiopsora* or *Phakopsora.*

Uredo Musae sp. nov.

Urediis hypophyllis, subepidermalibus, rotundatis, minutis, 65–120 μ diam., poro apertis, brunneis, laxe aggregatis vel plus minusve striiformibus;

urediosporae fere sessiles, late ellipsoideae, ellipsoideae vel obovoideae, (14–)17–21 × 24–30(–34) μ; membrana hyalina vel pallide brunneola, 1.5 μ cr., moderate echinulata; poris germ. obscuris.

On *Musa,* sp., Boana, May 6, 1936 (*8182*); Kajabit Mission, Sept. 8, 1939 (*10664*), Oct. 20, 1939 (*10779,* type).

The urediospores of this species have thinner and more strongly echinulate walls than described for those of *Uromyces Musae* P. Henn.

UREDO DIOSCOREA-SATIVAE Sydow.

On *Dioscorea* sp., Kajabit Mission, Dec. 8, 1939 (*10863L*); Wantoat, Jan. 7, 1940 (*10933*).

Uredo hiulca sp. nov.

Uredia hypophylla, subepidermalia, irregulariter rotundata vel elongata, 0.2–0.8 mm. longa, bullata, flavida, in maculis flavidis 1–3 mm. diam. aggregata vel sparsa; urediosporae ellipsoideae, obovoideae vel oblongae, 16–23 × 25–36 μ; membrana 1.5–2 μ cr., pallide flavida vel hyalina, minuteque echinulata; poris germ. obscuris sed 6–8 plus minusve aequatorialibus.

On *Dioscorea* sp., Finschhafen, Sept. 3, 1935 (*51*); Kajabit Mission, Nov. 27, 1939 (*10930,* type), Jan. 4, 1940 (*10917A*).

The spores of this species are of about the same size as those of *Uredo Dioscoreae-sativae* Sydow, but the sori are larger and have no peridium. Other species described on *Dioscorea* have smaller spores with the exception of *Uredo Dioscoreae-filiformis* Racib., which has larger, thicker-walled and more strongly echinulate spores.

UREDO ERYTHRINAE P. Henn.

On *Erythrina* sp., Lae, July 21, 1939 (*10461*); Kajabit Mission, Sept. 16, 1939 (*s. n.*).

Uredo wantoatensis sp. nov.

Uredia hypophylla, subepidermalia, rotundata, 0.3–0.8 mm. diam., pulverulenta, cinnamomea, in maculis brunneis usque ad 3 mm. diam. aggregata; urediosporae late ellipsoideae, 15–18 × 18–23 μ; membrana aureo- vel cinnamomeo-brunnea, 1.5 μ cr., moderate echinulata; poris germ. 2, aequatorialibus.

On *Impatiens* sp., Wantoat, Jan. 9, 1940 (*10944A*).

Uredo wantoatensis perhaps will be found to have teliospores similar to those of *Puccinia argentata* (Schultz) Wint. and *P. Komarovi* Tranz. but should still be readily distinguishable since

the urediospores of *P. argentata* have several scattered pores while those of *P. Komarovi* have but a single pore.

UREDO OPHIORRHIZAE Petch.

On *Ophiorrhiza* sp., Ogeramnang to Bulung R., Jan. 4, 1937 (*4858*); Samanzing to Milulunga, July 5, 1939 (*s. n.*); Kajabit Mission, Oct. 20, 1939 (*10778F*).

AECIDIUM BREYNIAE Sydow.

On *Breynia* sp., Salamaua, Aug. 26, 1935 (*17*); Heldsbach, Sept. 15, 1935 (*122*); Kajabit Mission, Aug. 12, 1939 (*10571*).

Aecidium Breyniae is characteristic because of its hypophyllous, subcuticular, conical, minute pycnia, which measure only 20–35 μ in diameter.

Aecidium morobeanum sp. nov.

Pycnia epiphylla, subepidermalia, paraphysata, 100–130 μ diam. Aecia hypophylla, cupulata, 0.2–0.3 mm. diam., in maculis flavidis vel brunneis 2–12 mm. diam. disposita; cellulis peridii globoideis, ellipsoideis vel cuboideis, 21–30 μ diam., pariete interiore verrucoso 3 μ cr., exteriore minuteque striato 3 μ cr.; aeciosporae globoideae vel ellipsoideae, 22–29 × 28–33(–36) μ; membrana hyalina, 1.5–2 μ cr., moderate verrucosa.

On *Cordia dichotoma* Forst. f., Kajabit Mission, July 25, 1939 (*10493*, type), Sept. 21, 1939 (*s. n.*), Nov. 23, 1939 (*s. n.*), Dec. 1939 (*s. n.*).

The aeciospores of this rust are larger than those of *A. brasiliensis* Dietel, and *A. Lindavianum* Sydow, and lack the apical thickening characteristic of the spores of *A. Cordiae* P. Henn. No other spore form could be found and, since the material varied from fresh to old, the species is probably heteroecious.

AECIDIUM MICRANTHUM Sydow.

On *Psychotria* sp., Samanzing, Dec. 22, 1938 (*9443; 9444*).

AECIDIUM FLAVIDUM Berk. & Br.

On *Pavetta indica* L. var., Sattelberg to Quembung Mission, Nov. 26, 1935 (*1018*), Dec. 9, 1935 (*1174b*); Kajabit Mission, Aug. 18, 1939 (*10589*), Oct. 16, 1939 (*s. n.*).

AECIDIUM VERNONIAE-CINEREAE Petch.

On *Vernonia cinerea* Less., Boana, July 14, 1938 (*8475*); Kajabit Mission, Dec. 8, 1939 (*10860*).

AECIDIUM BLUMEAE P. Henn.

On *Blumea* sp., above Dantap, Jan. 4, 1940 (*10920*).

Aecidium papuanum sp. nov. (FIG. 7).

Pycniis epiphyllis, subepidermalibus, globoideis, 100–175 μ diam. Aeciis hypophyllis, cupulatis, recurvatis, flavidis, 0.2–0.3 mm. diam., per totam folii superficiem plus minusve aequaliter sparsis; cellulis peridii rhomboideis, 17–23 × 27–35 μ, pariete interiore verrucoso 3–5 μ cr., exteriore 3 μ cr. levi; aeciosporae globoideae, oblongae vel ellipsoideae, 15–23 × 19–26 μ; membrana pallide flavidula vel hyalina, 1 μ cr., ad apicem 2–5 μ cr., ubique sed praecique ad apicem moderate verrucosa.

On *Blumea hieracifolia* DC., Kajabit Mission, Dec. 19, 1939 (*10890*).

The mycelium of *A. papuanum* is at least locally systemic and the affected leaves are smaller and narrower than normal. It is the only systemic *Aecidium* known to parasitize *Blumea*.

THE ARTHUR HERBARIUM,
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A NEW SMUT FROM LOUISIANA

L. Wayne Lenz

(with 2 figures)

An interesting smut, apparently belonging to the genus *Tilletia,* has been collected a number of times during the past two years in Louisiana on two species of *Euphorbia.* The first collections were made by Mr. Alvaro Goenaga near Brusly, La., on *Euphorbia Preslii* Guss. Other collections, also made by Mr. Goenaga, included ones made in September, 1939, at Montegut, La., on *Euphorbia heterophylla* L. (*Poinsettia heterophylla* (L.) Small, according to Small's Manual of the Flora of the Southeastern States), and at Baton Rouge on *Euphorbia Preslii* Guss.

The sori of the smut occur in rather conspicuous spindle-shaped swellings (fig. 1, 2*a*) on the stems and peduncles. As these swellings split, the somewhat powdery black masses of spores are exposed. The spores (fig. 2*b–e*) germinate rather readily in a 1 to 100,000 benzaldehyde solution, each promycelium bearing 3–5 sporidia at the tip.

A search was made of all available literature but no record could be found of a smut having ever been reported as occurring on *Euphorbia* or any member of the Euphorbiaceae. As the smut collected in Louisiana is apparently new, it is here described as a new species, as follows:

Tilletia Euphorbiae sp. nov.

Sori forming conspicuous, usually spindle-shaped swellings on stems and peduncles, splitting longitudinally at maturity and exposing the black spore mass; spores rather firmly compacted in indefinite masses in the cortex, dark brown, subspherical to broadly oblong, irregular due to pressure, $11–17 \times 14–18\ \mu$ (average $14 \times 16\ \mu$), smooth, single or in small groups, but not forming definite balls. Germination by means of a short non-septate promycelium bearing at the tip 3–5 sporidia. Sporidia remaining attached and fusing or germinating directly by means of a germ tube.

Soris in stirpibus pedunculisque tumores manifestos et plerumque fusiformes efficientibus, maturis in longitudinem findentibus eoque massam sporarum nigram exhibentibus; sporis firmius compactis in massas informes in cortice sitas; atribrunneis, subglobosis vel late oblongis, propter pressionem irregularibus, 11–17 × 14–18 μ (mediis inter maxima minimaque 14–16 μ), glabris, singulis vel glomeratis, veros autem globos non facientibus.

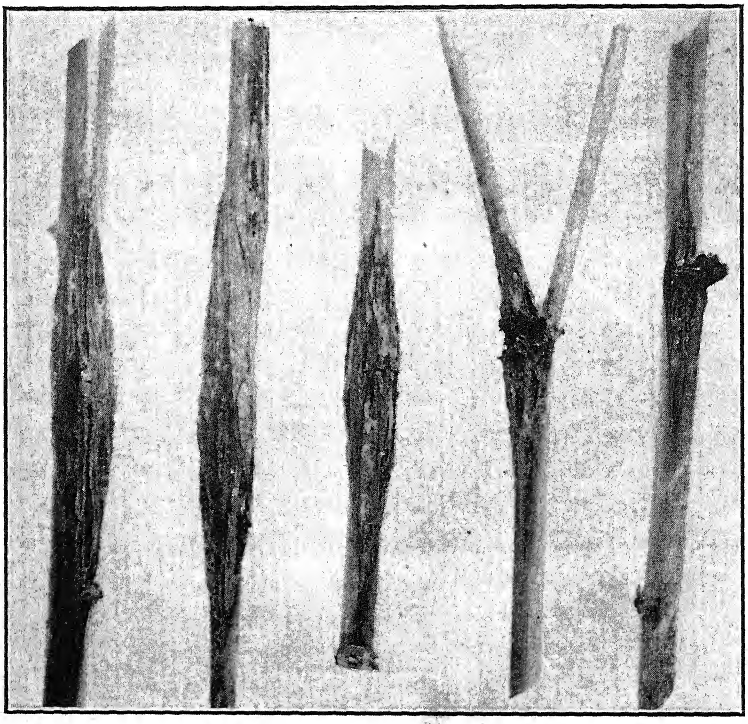

FIG. 1. *Tilletia Euphorbiae.*

Germinatio efficitur per breve promycelium non-septatum quod in cacumine 3–5 sporidia parit.

On Euphorbiaceae: *Euphorbia heterophylla* L. Type collected near Montegut, La., September, 1939, by Alvaro Goenaga, also collected on *E. Preslii* Guss. near Baton Rouge, La., September, 1939.

Herbarium material: The type specimens are deposited in the Mycological Collections of the Bureau of Plant Industry, United

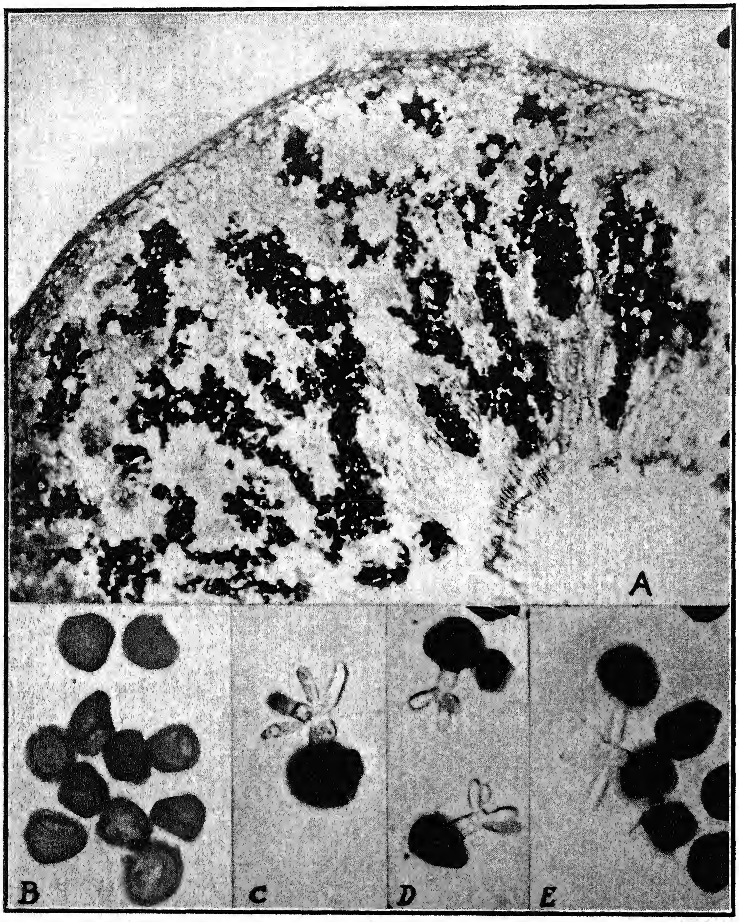

FIG. 2. *Tilletia Euphorbiae.*

States Department of Agriculture at Washington, D. C. Duplicate material is deposited in the herbarium of Louisiana State University, University, La., and the Zundel Herbarium.

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A CONTRIBUTION TO THE LIFE HISTORY AND GEOGRAPHIC DISTRIBUTION OF THE GENUS ALLOMYCES

Fred T. Wolf

(with 2 figures)

INTRODUCTION

Almost thirty years ago Butler (1911) discovered in India a peculiar aquatic fungus to which he gave the name *Allomyces arbuscula*. This organism is a member of the phycomycetous order Blastocladiales, and possesses two distinct types of sporangia; thin walled zoösporangia, liberating posteriorly uniciliate zoöspores, and thick walled or resistant sporangia, which, after a period of dormancy, release zoöspores similar in all respects to those from the zoösporangia.

It remained for Kniep (1929) to describe from Java a second species, *A. javanicus*, which, while having zoösporangia and resistant sporangia as in *A. arbuscula*, also produced paired gametangia liberating male and female gametes structurally similar to the zoöspores except in size. In the next year, Kniep (1930) discovered that the gametangia were not produced on the same mycelium as were the two kinds of sporangia; in fact, the life cycle of *A. javanicus* was shown to be characterized by an alternation of generations. The male and female gametangia produced on the sexual mycelium were observed to liberate gametes which fuse to form a motile biciliate zygote, which in turn develops into an asexual mycelium. On the asexual mycelium are borne the thin walled zoösporangia, whose zoöspores form new asexual plants, and thick walled or resistant sporangia, germinating to produce zoöspores which develop into sexual plants. A subsequent reëxamination of *A. arbuscula* by Hatch (1933, 1935) disclosed a life cycle identical with that of *A. javanicus*. The distinction between the two species rests, however, on the arrangement

of the gametangia: in *A. javanicus* the male gametangium is terminal or epigynous with respect to the female, whereas in *A. arbuscula* this situation is reversed, the male gametangium being hypogynous.

A third species, *A. moniliformis,* was described by Coker and Braxton (1926) from North Carolina, partially on the basis of the fact that the resistant sporangia are characteristically elongate, thus differing markedly from the bluntly rounded resistant sporangia of *A. arbuscula* and *A. javanicus.* The life cycle of *A. moniliformis* has recently been shown (Emerson, 1938) to be quite different from that of *A. javanicus* and *A. arbuscula.* In this species, zoöspores from the resistant sporangia have been found to be biciliate rather than uniciliate; after a very brief period of motility they encyst, lose their cilia, and each cyst germinates to give rise to a group of four "secondary" zoöspores, each of which is uniciliate and eventually develops into a plant like the immediate parent; *i.e.* bearing the two kinds of sporangia. There is thus no obvious alternation of generations, as in *A. arbuscula* and *A. javanicus.* A fourth species, entirely similar in its life cycle to *A. moniliformis* but with resistant sporangia which are not elongate, has been studied by Emerson (1938) and is soon to be described by him under the name *A. cystogenus* (see Emerson and Fox, 1940). On the basis of these fundamental differences in the life cycles of members of the genus, Emerson (1939) has erected the subgenera *Euallomyces* (to include the two long cycled forms) and *Cystogenes* (to include the two cyst-forming species not having alternation of generations).

Still a third life cycle has been shown to exist within the genus; in *A. anomalus* Emerson (1937, unpublished) the mycelia bear the characteristic zoösporangia and resistant sporangia resembling those of *Euallomyces,* yet zoöspores from the resistant sporangia develop directly into asexual plants like the parent; *i.e.,* there is no indication of any sexuality whatsoever. The subgenus *Brachyallomyces* (Emerson, 1939) has been created for this short cycled form.

The present paper has as its aim the presentation of data concerning some 43 new isolates of *Allomyces,* collected by the writer and others during the past several years, and including all of the

described species. Except when otherwise stated, the isolation and identification of the various forms were carried out by the author. This account involves considerable extensions in the known geographic distribution of the genus, and it is to be hoped

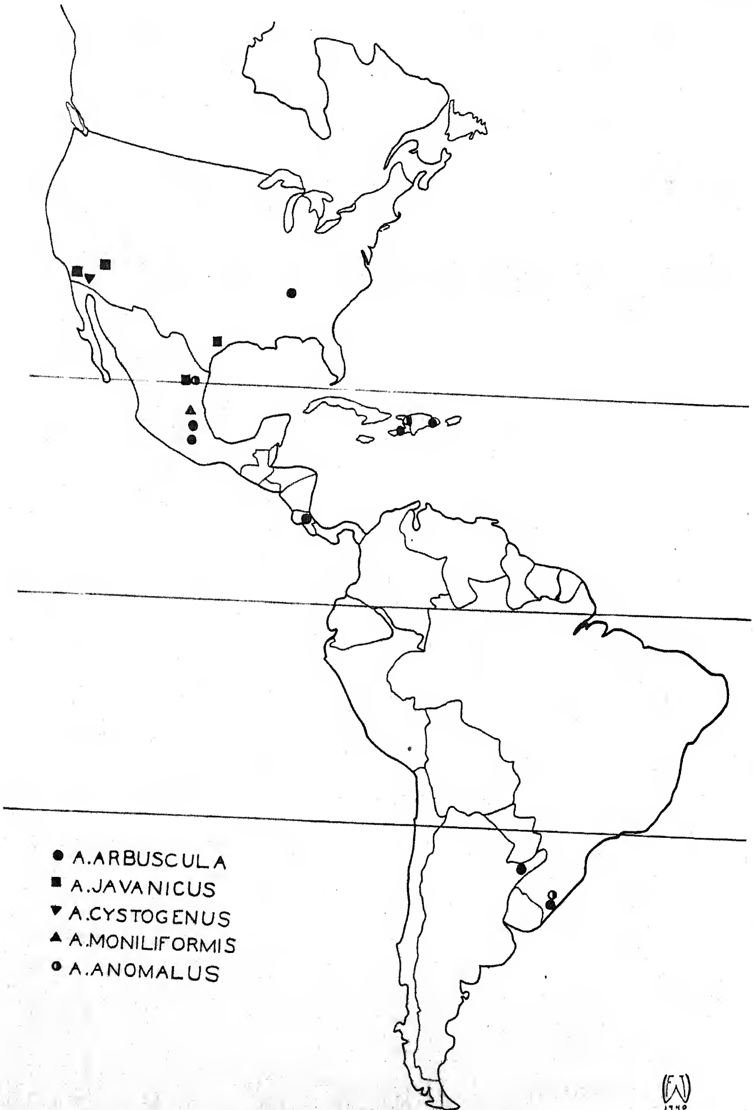

FIG. 1. Geographic distribution of the 36 isolates of *Allomyces* obtained from the western hemisphere.

that the information concerning the life cycles of the various isolates will serve to place the taxonomy of the genus, as worked out by Kniep, Hatch, Emerson and others, on a firmer basis.

MATERIALS AND METHODS

Previous workers have shown that the various species of *Allomyces* are to be found under exceedingly diverse environmental conditions both in fresh water and in the soil, and that the resistant sporangia of the fungus are capable of persisting in a dormant but viable condition in the soil for periods of several months or longer. The use of soil samples as a means of obtaining isolates for study has proved to be very satisfactory in the previous experience of the author and others, and hence was used throughout the present work. Inasmuch as it has been impossible for the author to visit personally all of the localities from which collections were made, this report is based almost entirely on collections made by others. The soil samples were collected in a moist condition and allowed to become air dry before shipment. Wrapping of the samples individually in heavy paper precluded the possibility of contamination of one sample with inoculum from another.

Isolation of the fungi was accomplished by placing the soil in a sterile Petri dish with sterile distilled water and using boiled hemp seed as a nutrient substratum. Successive transfers served to free the culture of the bulk of the miscellaneous protozoa, bacteria, and fungi occurring in the soil sample. All observations were based on water cultures of the fungi growing on hemp seed under ordinary laboratory conditions. For purposes of convenience in discussion, each culture was designated by the name of the locality from which it had been collected, together with a number.

One of the chief taxonomic problems of this particular genus is concerned with the possibility of distinguishing between the various species on the basis of asexual characters alone. Although any such evidence must be regarded as presumptive, and confirmed by a careful study of the entire life cycle, nevertheless, the possibility of attempting the correlation of such an obvious character as the size of the resistant sporangia with a particular life cycle or sexual stage is an intriguing one, well deserving of study. Con-

sequently, a series of measurements was made upon the resistant sporangia of each *Allomyces* isolate, and, in order that the results might be comparable, the procedure was carefully standardized. Following a considerable amount of experimentation, it was finally decided to make all measurements on actively growing cultures 5–8 days in age, as experience showed that the vast majority of the resistant sporangia had reached maximal size in this period, whereas older cultures, in which the nutrient supply was practically

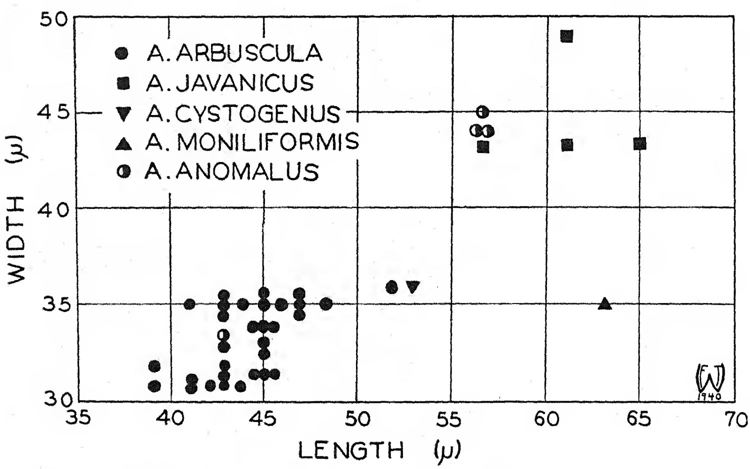

FIG. 2. Graphic representation of the measurements of the resistant sporangia of the various isolates of *Allomyces*.

exhausted, tended to contain a disproportionate quantity of small resistant sporangia. Measurements were made with an ordinary eyepiece micrometer previously calibrated against a standard, and, with the exception of the data concerning the six Mexican isolates reported previously (Wolf, **1939**) and included here for purposes of comparison, the same micrometer, calibration chart, microscope, and observer were used throughout. 100 measurements of the length and 100 measurements of the width of the resistant sporangia of each isolate were made at random. In the case of seven isolates whose large resistant sporangia proved to be more variable in size, the number of measurements was increased to 150.

The results (Table I) are expressed in terms of the mode, rather than the mean, since the frequency distribution curves for resistant

sporangial size are unsymmetrical in character. In expressing the range of variation, 75 per cent of the measurements are included within the arbitrarily established limits, 12.5 per cent of the largest and a similar number of the smallest resistant sporangia being excluded by this procedure.

In conjunction with the measurements carried out on the resistant sporangia of each isolate, the resistant sporangia were germinated in order to work out the complete life cycle. The technique used is a very simple one involving the removal of actively growing asexual mycelia on hemp seed from the water culture, placing them on filter paper, and allowing them to dry out for varying lengths of time (2 weeks to several months). This operation will kill the mycelium and zoöspores from thin walled sporangia, but does not harm the thick walled resistant sporangia. Inasmuch as the resistant sporangia of most isolates will germinate readily when hemp seed and water are again added, this offers an easy and convenient method of obtaining sexual plants for study, and also a means of storing cultures for future use. Inasmuch as the experience of Emerson (**1939**) with *A. anomalus,* and that of Sörgel (**1937**) with certain strains of *A. arbuscula* indicates that resistant sporangia may germinate to produce asexual plants rather than sexual ones, the formation of asexual plants following one such germination experiment does not mean that the same isolate may not again produce sexual plants on another occasion. Consequently, the germination attempts were carried out repeatedly when the sexual stage was not produced, and in many instances, after the consistent production of asexual plants on successive germinations, the sexual stage finally appeared, permitting a species identification to be made.

LIST OF ISOLATES

Inasmuch as so very little is known about the ecological conditions under which *Allomyces* lives in nature, it has been thought wise to include here rather detailed notes concerning the localities from which collections were made, at least in all cases in which this information was available. The approximate location of the sources of the 36 western hemisphere isolates may be seen from the accompanying map (FIG. 1). For purposes of convenience in

TABLE I

COMPARATIVE MEASUREMENTS OF THE RESISTANT SPORANGIA OF THE ISOLATES OF *Allomyces*

	Width (mode in μ)	Length (mode in μ)	75% or more between	
			Width (μ)	Length (μ)
Allomyces arbuscula				
Mexico 26	34	45	28–37	38–48
Mexico 29	34	43	28–38	38–48
Mexico 37	34	45	28–38	40–50
Costa Rica 1	35	47	31–38	40–48
Costa Rica 2	31	44	29–36	39–48
Costa Rica 4	35	45	31–38	40–50
Costa Rica 7	37	52	33–40	46–54
Dominican Rep. 3	31	41	28–34	36–46
Haiti 5	35	46	31–37	43–50
Haiti 11	31	39	28–34	36–44
Haiti 14	35	47	30–38	42–51
Brazil 1	32	45	29–37	41–51
Brazil 2A	32	39	27–35	34–44
Brazil 5	35	43	31–39	39–46
Brazil 2B	33	43	28–36	38–48
Brazil 6	33	45	30–37	39–48
Brazil 9	35	45	31–38	42–49
Brazil 11	31	42	27–34	38–46
Argentina 1	31	43	28–36	38–48
Argentina 2	35	47	31–38	43–50
Argentina 3	32	45	30–36	40–49
Argentina 5	31	43	27–35	38–48
Argentina 6	31	41	26–34	36–44
China 3	34	45	29–37	41–49
China 4	35	44	31–38	39–49
China 5	35	41	30–39	37–46
China 6	35	43	31–37	39–47
China 10	31	43	28–37	38–46
South Africa 1	33	45	30–37	40–49
South Africa 5	32	45	30–38	40–48
Tennessee 1	35	48	33–39	44–52
Allomyces javanicus				
Mexico 17	43	57	34–48	46–61
Texas 1	43	61	37–48	55–70
Utah-Arizona 1	49	61	42–54	54–70
California 1	43	65	38–46	56–70
Allomyces moniliformis				
Mexico 46	35	63	31–38	54–70
Allomyces cystogenus				
Arizona 1	37	53	32–41	46–55
Allomyces anomalus				
Mexico 16	45	57	33–48	45–61
Haiti 7	44	57	38–48	52–67
Haiti 8	44	57	39–49	52–63
Brazil 7	33	43	29–36	38–46

drawing comparisons, the data concerning the measurements of resistant sporangia have been assembled in tabular form (Table I).

ALLOMYCES ARBUSCULA Butler (**1911**) em. Hatch (**1933**, **1935**).

This species has proved to be by far the most common and widespread member of the genus. On germination of zoöspores from the resistant sporangia, there are produced, at least occasionally, sexual plants bearing paired gametangia. As described by Hatch (**1933**, **1935**), the smaller male gametangium, which is orange pigmented, is hypogynous, while the grayish female gametangium is terminal with respect to the male. Recent work by Emerson and Fox (**1940**) has demonstrated that the coloration of the male gametangium is due to the presence of gamma carotene. There follows an enumeration of the isolates characterized by the possession of such gametangia:

MEXICO 26. Isolated from moist soil collected on August 16, 1937 in the Borda Gardens, Cuernavaca, Morelos, by the author. This isolate was subjected to repeated germination attempts at intervals of several weeks from September, 1937, to June, 1938, resulting in the consistent production of asexual plants. It was therefore described (Wolf, **1939**) as *A. anomala*. Subsequent work by Emerson, however, has demonstrated the existence of a gametophyte of the *A. arbuscula* type.

MEXICO 29. Isolated, as the preceding, from moist soil collected in the Borda Gardens, Cuernavaca, Morelos, on August 16, 1937, by the author.

MEXICO 37. Isolated from mud collected in a roadside ditch near Tepexpan, 6 km. east of Venta de Carpio, on August 18, 1937, by the author.

COSTA RICA 1. Collected by Prof. Rafael L. Rodriguez from the bottom of a shallow pond or puddle covered over with algae and drying up due to lack of rain, near San José, C. R., on November 18, 1939.

COSTA RICA 2. Collected by Prof. Rafael L. Rodriguez from the banks of the Rio Maria Aguila, near San José, C. R., on November 18, 1939.

COSTA RICA 4. Collected by Prof. Rafael L. Rodriguez from a

ditch shaded by trees, near San Dimas, south of San José, C. R., on January 20, 1940.

COSTA RICA 7. Collected by Prof. Rafael L. Rodriguez from Cucubres Creek, south of Desamparados, C. R., on January 20, 1940.

DOMINICAN REPUBLIC 3. Collected by Edwin Anderson from a sink hole in coral rock, surrounded by *Osmunda cinnamomea,* near San Pedro de Macoris, D. R., on October 19, 1939.

HAITI 5. Collected by Arnauld Haspil, from the Cavaillon River, in southern Haiti, on December 1, 1939.

HAITI 11. Collected by Arnauld Haspil, from the Guinte River, in northern Haiti, on December 15, 1939.

HAITI 14. Collected by Arnauld Haspil, from the Momanee River in western Haiti, on December 2, 1939.

BRAZIL 1. Collected on a river bank, near Santa Cruz, Rio Grade do Sul, Brazil, on November 9, 1938, by J. M. Harris.

BRAZIL 2A. Collected in a ditch in a field near Stiendorff's farm, Candelaria, Rio Grande do Sul, Brazil, on November 9, 1938, by J. M. Harris.

BRAZIL 5. From the banks of the Rio Pardo, Candelaria, Rio Grande do Sul, Brazil, on November 9, 1938, by J. M. Harris.

BRAZIL 2B. Collected by W. Hofmann, in the arroio Linha Nova, near Santa Cruz, Rio Grande do Sul, Brazil, on February 13, 1939.

BRAZIL 6. Collected by W. Hofmann, in the arroio Linha Antao, near Santa Cruz, Rio Grande do Sul, Brazil, on February 13, 1939.

BRAZIL 9. Collected by W. Hofmann, in the Rio Castelhano, near Santa Cruz, Rio Grande do Sul, Brazil, on February 13, 1939.

BRAZIL 11. Collected by W. Hofmann, in the arroio Santa Cruz, near Santa Cruz, Rio Grande do Sul, Brazil, on February 13, 1939.

ARGENTINA 1. Collected by E. H. Gartner, from a ditch on the outskirts of Leandro N. Alem, Misiones, Argentina, on February 6, 1939.

ARGENTINA 2. Collected by E. H. Gartner, from a ditch on the outskirts of Leandro N. Alem, Misiones, Argentina, on February 6, 1939.

ARGENTINA 3. Collected by E. H. Gartner, from the river Arreame, Leandro N. Alem, Misiones, Argentina, on February 10, 1939.

ARGENTINA 5. Collected by E. H. Gartner, from the river Martires, Bonpland, Misiones, Argentina, on February 10, 1939.

ARGENTINA 6. Collected by E. H. Gartner, from the river Tacuaruzú, Leandro N. Alem, Misiones, Argentina, on February 10, 1939.

CHINA 3, 4, 5, 6, 10. Collected by Lee Ling from a rice field and the moist bank of a river near Chengtu, China, on February 9, 1939.

SOUTH AFRICA 1. Collected by Miss E. S. Moore from the bank of the Kat River, about a foot above the normal water level but covered during flood periods, near Balfour, Cape Province, South Africa, in March, 1939.

SOUTH AFRICA 5. Collected by Miss E. S. Moore from a roadside pool overgrown with bullrushes, on the Katberg road, near Balfour, Cape Province, South Africa, on January 22, 1940.

TENNESSEE 1. Collected by Miss Dorothy Hutchison in Hibbett's Creek, between Edwin Warner and Percy Warner Parks, near Nashville, Tennessee, on January 3, 1940.

ALLOMYCES JAVANICUS Kniep (**1929**).

This species, like *A. arbuscula,* is characterized by an alternation of generations. Paired gametangia are borne on the sexual mycelium, but their arrangement is just the reverse of that characteristic of *A. arbuscula.* In *A. javanicus,* the brightly pigmented male gametangium is epigynous with respect to the grayish female gametangium (Kniep, **1929**, **1930**).

MEXICO 17. Collected by the author from soil in the Rio Pilon, at its intersection with the Pan American Highway, 833 km. north of Mexico City, on August 13, 1937. This isolate was previously described (Wolf, **1939**) as *Allomyces* sp. indet., since the resistant sporangia proved difficult to germinate, and the life cycle was not worked out at the time of the previous report. The author made at that time (op. cit., p. 383) the following statement: "If a sexual stage is ultimately found, it will probably be of the *A. arbuscula* type, as no species with epigynous male gametangia has as yet been

found in the western hemisphere." Emerson, in June, 1939, succeeded in obtaining the sexual stage of this isolate, and has found that its male gametangia are indeed epigynous.

TEXAS 1. Isolated and identified by Dr. F. K. Sparrow, Jr., from soil collected by Prof. G. R. LaRue, in a bog near Grapeland, Texas, in the spring of 1939.

UTAH-ARIZONA 1. Collected and isolated by Dr. J. V. Harvey from dry sand in a wash in the Monument Valley near the boundary line between Utah and Arizona, on August 5, 1937.

CALIFORNIA 1. Collected and isolated by Dr. J. V. Harvey, in sand from a dry wash, Snow Creek, near Palm Springs, California, on February 25, 1940.

As stated above, these collections of *A. javanicus* are the first finds of this species in the western hemisphere. Although *Utah-Arizona 1* represents the earliest new world collection now known to be *A. javanicus,* it would appear that *Mexico 17* was the first isolate to be identified as such.

The sexual plants of the four isolates differ somewhat in the character of their female gametangia. Whereas in *Mexico 17* and *Utah-Arizona 1* the female gametangia are spherical or approximately so, those of *Texas 1* and *California 1* are very strikingly elongate. No difference of comparable degree was apparent among the 31 isolates of *A. arbuscula* studied, in which the gametangia of the various isolates are surprisingly uniform.

ALLOMYCES MONILIFORMIS Coker & Braxton (**1926**) em. Emerson (**1938**).

This species, characterized by elongated resistant sporangia, many of which are pointed at their apices, and by large, widely spaced pits in the wall of the resistant sporangium, has a life cycle involving cyst formation and the escape of secondary zoöspores from the cysts (Emerson, **1938**). It was collected but a single time, as follows:

MEXICO 46. Collected by the author from the Rio Axtla, at its intersection with the Pan American Highway, 399 km. north of Mexico City, on August 20, 1937 (Wolf, **1939**).

ALLOMYCES CYSTOGENUS Emerson (1940).

This species, with a life cycle similar to that of *A. moniliformis,* is to be erected to include the four isolates studied by Emerson (1938); the species name first appears in the paper by Emerson and Fox (1940). The following is the first report of its occurrence in North America:

ARIZONA 1. Collected and isolated by Dr. J. V. Harvey from dry clay in the Gila River, Yuma, Arizona, in March, 1940, and identified by the author.

ALLOMYCES ANOMALUS Emerson (1937, unpublished).

This species is characterized by a life cycle involving neither alternation of generations nor cyst-formation; sexual reproduction is apparently lacking completely. Four of the author's isolates apparently belong to this category.

MEXICO 16. Collected at the Rio Pilon at its intersection with the Pan American Highway, 833 km. north of Mexico City, on August 13, 1937, by the author (Wolf, 1939).

HAITI 7. Collected by Arnauld Haspil from the Coupe à l'Inde River, in central Haiti, on December 15, 1939.

HAITI 8. Collected by Arnauld Haspil from the Estère River, in central Haiti, on December 15, 1939.

BRAZIL 7. Collected by W. Hofmann, from the arroio Quarta Linha Nova, near Santa Cruz, Rio Grande do Sul, Brazil, on February 13, 1939.

Repeated germination of the resistant sporangia of these isolates has failed to give any indication of the possession of a sexual stage.

In addition to the various isolates of *Allomyces,* a parasite of this fungus was also collected, as follows:

ROZELLA ALLOMYCIS Foust (1937).

This chytrid, parasitic on *Allomyces arbuscula,* was originally described from North Carolina. Sporangia of the parasite, formed in sori at the tips of young *Allomyces* hyphae, liberate posteriorly uniciliate zoöspores which spread the infection. Large resting spores, 12–20 μ in diameter, with spiny brownish walls, are also produced several days following infection. It is not known

whether or not species of Allomyces other than *A. arbuscula* are subject to attack by this organism. Two isolates of *R. Allomycis* were obtained:

BRAZIL 3. On *A. arbuscula,* from a soil sample collected by W. Hofmann in the river Taquary-Mirim, near Santa Cruz, Rio Grande do Sul, Brazil, on February 13, 1939.

ARGENTINA 4. On *A. arbuscula,* from a soil sample collected by E. H. Gartner from the river Arreame, Leandro N. Alem, Misiones, Argentina, on February 10, 1939.

This parasite has not previously been found to occur in South America. It is easily kept in culture by adding young non-parasitized colonies of *A. arbuscula* to the water culture of the parasitized material, as described by Foust (**1937**), and the resting bodies, when the host material is dried out on filter paper, are capable of remaining viable for several months.

DISCUSSION

The results of the present study would seem to indicate that *Allomyces arbuscula,* and, to a lesser extent, other members of the genus as well, are of fairly common occurrence in moist soils. The finding of this species in the United States, Mexico, the West Indies, Costa Rica, Brazil, and Argentina indicates a rather widespread geographic distribution in the tropical and temperate portions of the western hemisphere, and there seems to be no reason for supposing that future investigations will not disclose a similar lack of endemism in the warmer portions of the eastern hemisphere as well. It is perhaps remarkable that a species having such a wide range as *A. arbuscula* shows so little variation in size of resistant sporangia and characters of the gametangia as is the case.

No correlation whatever seems possible between the observed distribution of this species and the soil type in which it occurs. Isolates were obtained from soils ranging from very rich mucky soils, high in organic matter, to heavy clays, loams, and even sand. Likewise, the factors responsible for bringing about the distribution of such a form in such different geographic and edaphic environments as those in which it occurs, remain almost entirely unknown.

The occurrence of the epigynous species, *A. javanicus,* in the western hemisphere is of especial interest, in view of the fact that it was originally described from Java, and is now known in this hemisphere from at least four localities in the southwestern United States and Mexico, but not elsewhere. Likewise, the finding of *A. cystogenus* for the first time in North America, and the occurrence of *Rozella Allomycis*, reported for the first time from South America, show that our knowledge of the distribution of these forms is far from complete.

The results of the measurements of the resistant sporangia of the various isolates of *Allomyces* indicate that at least a tentative separation between the two long-cycled species, *A. arbuscula* and *A. javanicus*, is possible, using this criterion (FIG. 2). In general, the resistant sporangia of *A. javanicus* are both longer and broader than those of *A. arbuscula.* Whether or not this criterion can be safely used in all cases can be decided only after further study of additional isolates from other localities. Yet the use of measurements, when later confirmed by the germination of the resistant sporangia and observations on the sexual plants, has, in the author's experience, served as an excellent working hypothesis in the identification of the species characterized by an alternation of generations.

Resistant sporangia of the author's isolate of *A. moniliformis* and that described by Coker and Braxton (1926) would appear roughly comparable to those of *A. arbuscula* in width, and to those of *A. javanicus* in length. In *A. moniliformis* and *A. cystogenus,* the wide pits in the wall of the resistant sporangia and the presence of the characteristic cysts as described by Emerson (1938) offer taxonomic characters of such distinctiveness as to relegate the use of measurements to a position of much less importance in determining species. When more isolates of these cyst-forming species are obtained, however, it is possible that biometric methods could better be used to advantage in helping to delimit the various species of the genus *Allomyces* as Gäumann (1923) has done in the genus *Peronospora.*

It is a pleasure to acknowledge the numerous courtesies extended to the author during the progress of this work, a portion of which was carried out during the tenure of a National Research Fellow-

ship in Botany at Harvard University, under the supervision of Professor William H. Weston, Jr., who has provided numerous suggestions and continued encouragement. Dr. Ralph Emerson has been most helpful on many occasions. The writer also wishes to extend his thanks to Dr. F. K. Sparrow, Jr., Dr. J. V. Harvey, Professor Rafael Rodriguez, Edwin Anderson, Arnauld Haspil, J. C. Hart, J. M. Harris, W. Hofmann, E. H. Gartner, Lee Ling, Miss E. S. Moore, Miss Dorothy Hutchison, and Dr. F. A. Wolf for sending cultures or soil samples or helping to secure them, to Mrs. Charles Rick for caring for certain of the cultures during the summer of 1939, and to Miss Ann Vaughn for assistance in making the measurements.

SUMMARY

Allomyces arbuscula has a rather wide geographic distribution, having been found in the United States, Mexico, the West Indies, Costa Rica, Brazil, Argentina, China, and South Africa. Isolates from the various localities appear to be very constant in the characters of their resistant sporangia and gametangia.

Allomyces javanicus is reported for the first time in the western hemisphere, from collections in Mexico, Texas, and the southwestern United States.

Allomyces cystogenus is reported for the first time from North America, from Arizona, and *Rozella Allomycis*, a parasite of *A. arbuscula*, has been found to occur in Argentina and Brazil.

It is suggested that the two long cycled species, *A. arbuscula* and *A. javanicus*, can be very conveniently separated on the basis of resistant sporangial size.

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NOTES ON OKLAHOMA CERCOSPORAE

W. WINFIELD RAY

During the course of the last two summers a number of species of *Cercospora* affecting various plants have been collected in Oklahoma. Samples of some of these have been sent to Dr. C. D. Chupp for study, and among them he discovered four new species.

At the request of Dr. Chupp, who generously suggested names for some of the species and technical descriptions for all, the following new species are described:

1. **Cercospora viburnicola** sp. nov.

Maculae angularibus vel irregularibus, levis vel largae, rubro-brunneis vel caesio-brunneis; fungus amphigenus, plerumque in dense fasciculatis; conidiophoris dilute olivaceo-brunneis, in masse mediocriter nigeris, rectis vel nonnihil curvatis vel undulatis, raro semel geniculatis, non-ramosis, attenuatis vel nonnihil irregularibus, parce septatis, ad apices pallescatis subtruncatisque, 4–6 × 25–75 μ; conidiis hyalinis, acicularis vel obclavatis, rectis vel nonnihil curvatis, pluriseptatis, septis inconspicuis, ad bases truncatis, ad apices acutis vel subacutis, 2–4 × 20–80 μ.

Hab. in foliis *Viburnum Opulus.*

Leaf lesions angular to irregular involving small to large portions of leaf, reddish-brown to grayish-brown; fruiting amphigenous and usually in dense fascicles; conidiophores pale olivaceous brown, in mass medium dark, straight to slightly curved or undulate, rarely once geniculate, not branched, tip slightly paler, attenuated or somewhat irregular in width, sparingly septate, medium spore scar at subtruncate tip, 4–6 × 25–75 μ; conidia hyaline, acicular to obclavate, straight or slightly curved, indistinctly multiseptate, truncate at the base with subacute to acute tips, 2–4 × 20–80 μ.

Hab.: On leaves of *Viburnum Opulus* in Stillwater, Oklahoma, August 1939.

Type: In the herbarium of the Department of Plant Pathology, Cornell University, No. *29236.*

2. **Cercospora Coreopsidis** sp. nov.

Maculae orbiculares, 2–5 mm. diametro, marginibus elevatis et dilute brunneis, in centrum caesiae vel alutaceae; plerumque fungus epiphyllus;

stromatis cellis paucis tenus 40 μ diametro, atro-fuligenis; plerumque in dense fasciculatis, raro valde dense; conidiophoris in masse nigeris, singulatim dilute fuligenis, nonnihil ad apices attenuatis et pallescatis, 1–3 septatis, non-ramosis, rectis vel leviter curvatis vel tortuosis, raro semel geniculatis, 4–6 × 15–75 μ; conidiis hyalinis, acicularis vel obclavatis, conidiis brevissimis cylindraceis, rectis vel nonnihil curvatis, septis inconspicuis, ad bases truncatis vel subtruncatis, ad apices subacutis, 2–4 × 15–100 μ.

Hab. in foliis *Coreopsis grandiflora.*

Leaf spots circular, 2–5 mm. in diameter, pale brown raised margin and a gray to tan center; fruiting mostly epiphyllous, stromata a few cells to 40 μ in diameter, dark fuligenous; most fascicles dense, rarely very dense; conidiophores dark in mass, but pale fuligenous singly, somewhat paler and attenuate toward the tip, 1–3 septate, not branched, straight to curved or tortuous, rarely once geniculate, 4–6 × 15–75 μ; conidia hyaline, acicular to obclavate, shortest ones may be cylindric, straight to slightly curved, indistinctly multiseptate, truncate to subtruncate base, tip subacute, 2–4 × 15–100 μ.

Hab.: On leaves of *Coreopsis grandiflora* (Mayfield var.) in cultivated garden, Stillwater, Oklahoma, July 1940.

Type: In the herbarium of the Department of Plant Pathology, Cornell University, No. *29234*.

3. **Cercospora Cercidis** sp. nov.

Maculae orbiculares vel angularibus, 0.5–2 mm. diametro, atro-brunneis, interdum in centrum dilutiore cum corono flavo; fungus hypophyllus; stromatis solum cellis paucis, brunneis; interdum in dense fasciculatis; conidiophoris dilute olivaceo-brunneis, uniformis in coloris et latitudinis, parce septatis, non-ramosis, usitate semel geniculatis, ad apices rotundatis vel subtruncatis, 3–4.5 × 15–40 μ; conidiis subhyalinis vel prope coloratis, obclavatis, ad basis obconico-truncatis, rectis vel nonnihil curvatis, ad apices abruptis, 1–4 septatis, 4–6 × 20–50 μ.

Hab. in foliis *Cercis canadensis.*

Leaf lesions circular to angular, 0.5–2 mm. in diameter, dark brown, sometimes with paler center and yellow halo; fruiting hypophyllous; stromata of only few brown cells; some fascicles dense; conidiophores pale olivaceous brown, fairly uniform in color and width, sparingly septate, not branched, but geniculation may be slightly extended, usually one geniculation or 1 to 2 spore scars very near or almost at tip, 3–4.5 × 15–40 μ; conidia obclavate, subhyaline or almost colored, base short to long obconically truncate, straight to slightly curved, tip blunt, 1–4 septate, 4–6 × 20–50 μ.

Hab.: On leaves of *Cercis canadensis* in Stillwater, Oklahoma, August 1939.

Type: In the herbarium of the Department of Plant Pathology, Cornell University, No. *29235*.

4. **Cercospora Psoraleae** sp. nov.

Maculae orbiculares, 0.5–2.5 mm. diametro, caliginoso-brunneis, supera marginibus angustis elevatis; fungus epiphyllus; plerumque stromatis solum cellis paucis, hyphas conidiferas dense fasciculatas gerentibus, caulis 2–10, per occasionem tot 30; conidiophoris mediocriter atrofuligeneis ad bases sed superne pallescatis attenuatisque, pluriseptatis, rectis vel curvatis, raro semel geniculatis, non-ramosis, ad apices rotundatis vel subtruncatis, 4–5.5 × 20–140 μ; conidiis hyalinis, acicularis, rectis vel nonnihil curvatis, pluriseptatis, septis inconspicuis, ad bases truncatis, ad apices subobtusis, 2–4 × 20–100 μ.
Hab. in foliis *Psoralea digitata*.

Leaf spots circular, 0.5–2.5 mm. in diameter, dull brown, on upper surface with raised line border; the stromata mostly only a few dark cells, giving rise to fascicles of usually 2–10 stalks, but occasionally as many as 30; conidiophores medium dark fuligenous near base, paler and more narrow toward tip, multiseptate, straight to curved, rarely once geniculate, not branched, medium spore scar at rounded to subrtuncate tip, 4–5.5 × 20–140 μ; conidia hyaline, acicular, straight to slightly curved, indistinctly multiseptate, base truncate, tip subobtuse, 2–4 × 20–100 μ.

Hab.: On leaves of *Psoralea digitata* in Stillwater, Oklahoma, July 1940.

Type: In the herbarium of the Department of Plant Pathology, Cornell University, No. *29233*.

The following species, which have been deposited in the Cryptogamic Herbarium at the Oklahoma A. and M. College, have been collected in Oklahoma during the past several years by the author:

5. CERCOSPORA ACALYPHAE Peck.

On *Acalypha ostryaefolia* Rid., Stillwater, Aug. 18, 1939, No. 256.

6. CERCOSPORA ANTHELMINTICA Atk.

On *Chenopodium hybridum* L., Ripley, Sept. 23, 1939, No. 244.

7. CERCOSPORA ASPARAGI Sacc.

On *Asparagus officinalis* L., Perkins, Oct. 1938, No. 14.

8. CERCOSPORA CRUENTA Sacc.
On *Vigna sinensis* (L.) Endl., Berwyn, Aug. 13, 1938, No. 288.

9. CERCOSPORA DUBIA (R.) Wint.
On *Chenopodium album* L., Stillwater, July 3, 1940, No. 1505.

10. CERCOSPORA FLAGELLARIS Ellis & Martin.
On *Phytolacca decandra* L., Stillwater, Aug. 14, 1939, No. 269.

11. CERCOSPORA GAURAE Kellerm. & Swingle.
On *Gaura biennis* L., Stillwater, Aug. 18, 1939, No. 214.

12. CERCOSPORAE HYDRANGEAE Ellis & Ev.
On *Hydrangea arborescens* L., Stillwater, Aug. 19, 1939, No. 248.

13. CERCOSPORA OCULATA Ellis & Kellerm.
On *Vernonia Baldwini* Torr., Stillwater, Aug. 18, 1939, No. 257.

14. CERCOSPORA PACHYPUS Ellis & Kellerm.
On *Helianthus annuus* L., Stillwater, Aug. 21, 1939, No. 247.

15. CERCOSPORA PETUNIAE Mull. & Chupp.
On *Petunia hybrida* Vilm., Stillwater, July 9, 1940, No. 1545.

16. CERCOSPORA SQUALIDULA Peck.
On *Clematis Pitcheri* T. & G., Stillwater, June 29, 1940, No. 1475.

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THE DISTRIBUTION AND ASSOCIATION OF GONATORRHODIELLA HIGHLEI WITH NECTRIA COCCINEA IN THE UNITED STATES

Theodore T. Ayers [1]

(with 1 figure)

Introduction

Gonatorrhodiella Highlei A. L. Smith, one of the rarer members of the Fungi Imperfecti, is interesting not only because of its unusual morphology, but because of its close association with *Nectria coccinea* (Pers.) Fries,[2] one of the organisms involved in the beech bark disease (3) in North America. The growth of this fungus with *N. coccinea* is especially notable because *G. Highlei* was discovered growing originally on onion bulbs in England (7).

The first American collection of *Gonatorrhodiella Highlei* was made, as far as can be determined, by Dr. Haven Metcalf and Dr. Rush P. Marshall, who found it growing in association with *Nectria coccinea* and the scale insect (*Cryptococcus Fagi* (Baer.)) on beech trees (*Fagus grandifolia* Everhart) near Perry, Maine, in 1933. Collections made at that time were submitted to the writer for identification.

Subsequent observations made by the writer in different sections of Maine showed that *Gonatorrhodiella Highlei* growing on beech trees attacked by *Nectria coccinea* and *Cryptococcus Fagi* formed unusually conspicuous, irregular patches consisting of vegetative and fertile hyphae, the latter being cinnamon-buff to clay or rarely tawny [3] in color. These patches, which range from a

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[2] The specific name *Nectria coccinea* is used here, although Ashcroft (1) has pointed out that the species of *Nectria* implicated in the beech bark disease agrees with the type material of *Nectria ditissima* Tul. and Fries has depicted *N. coccinea* as having elongated-filiform ascospores.

[3] Ridgway, R. Color Standards and Color Nomenclature, Washington, D. C. 1912.

few square millimeters to several square centimeters in area, may be confined to a small section of the tree or they may be distributed intermittently or continuously up the tree as high as 10 meters above ground, virtually covering the side of the tree attacked by *N. coccinea.* In fact, the presence of *N. coccinea* on a tree may be detected readily because of the color of *G. Highlei.*

Since a review of the literature has shown that *Gonatorrhodiella Highlei* has not been previously reported in American mycological literature and because of its association with *Nectria coccinea,* one of the organisms responsible for the beech bark disease (3) in North America, the first report of the presence of this organism in the United States is herein given, and attention is called to the differences between it and other species of the genus *Gonatorrhodiella,* especially *G. parasitica.* This latter species collected originally in Connecticut was described by Thaxter (8) as a monotypic species of a new genus and is the only species of this genus heretofore reported from North America.

COMPARISON OF GONATORRHODIELLA HIGHLEI WITH OTHER SPECIES OF THE SAME GENUS

A comparison of *Gonatorrhodiella Highlei* with type material of *G. parasitica* showed that these two species differ chiefly in their morphological characters. In *G. Highlei* microscopic examination showed that the nodal sporiferous cells, designated as basal cells by Thaxter (8) and primary conidia by Smith and Rea (7), attached to the subspherical or ellipsoidal terminal or intercalary swellings of the conidiophores are obovate or pyriform (FIG. 1 B, F) and are larger in diameter than the components of the conidial chains, while the nodal cells of *G. parasitica* are elliptical and about equal in diameter to the conidia borne by them. Instead of a single, simple conidial chain attached to each nodal cell, as in *G. parasitica,* the obovate or pyriform nodal cells of *G. Highlei* bear usually three chains of conidia (FIG. 1 F), which in turn bud off spores laterally, thus forming a complex chain of conidia. These two organisms differ macroscopically also. For example, the conidiophores of *G. parasitica* were reported by Thaxter (8) to be about 1 mm. in height while those of *G. Highlei* from the writer's collections were found to be .2–.4 mm. in height. Furthermore, an examination of

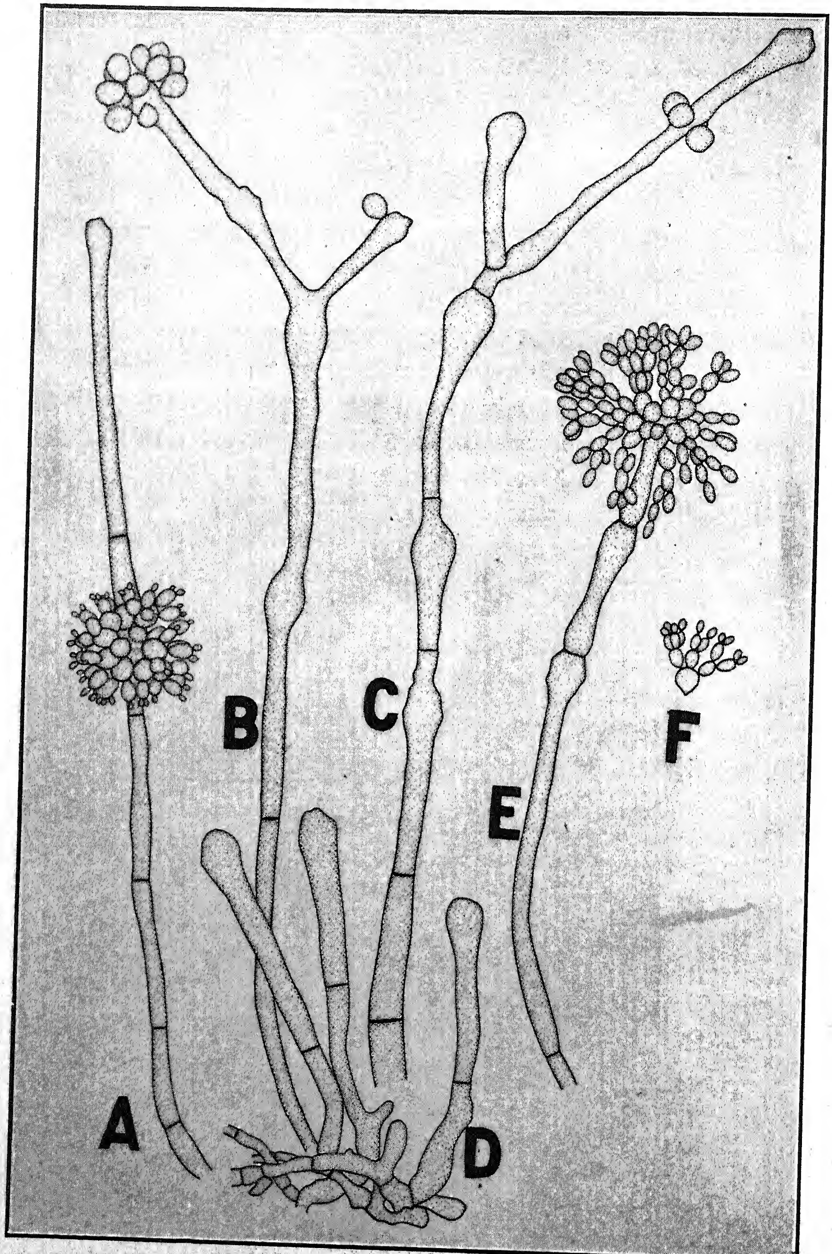

FIG. 1

the available collections of these two fungi showed that *G. Highlei* growing on *N. coccinea* in artificial culture as well as in nature was cinnamon buff, clay, or rarely tawny in color (Ridgway), while *G. parasitica* was cinnamon-rufous (Ridgway) when cultivated on *Trichoderma lignorum* (Tode) Harz growing on agar media. Never having collected *G. parasitica* in the field, the writer used as a comparison, cultures of *G. parasitica* obtained from Ross W. Davidson, who isolated this fungus together with *Trichoderma lignorum* (Tode) Harz from a malformed sporophore of *Polyporus* sp., and from river birch (*Betula nigra* L.) decayed by *Fomes* sp. Because he was unable to culture the *Gonatorrhodiella* in the absence of *T. lignorum*, Davidson (Plant Disease Reporter XIX, No. 7 1935) believed that *G. parasitica* was parasitic on it.

A species growing on *Tremella lutescens* Pers. was collected by von Hoehnel (4) in Europe and described by him as *Gonatorrhodiella eximia*. In comparing type material of this species with that of *G. parasitica*, the writer found no marked differences between these two species and therefore considers the names to be synonyms for the same fungus. On the other hand, a comparison of the description and illustrations of collections of *G. Highlei* made in England and collections of this fungus from North America with authentic material of *G. eximia*, showed that they are distinct species. It is interesting from the standpoint of geographical distribution of fungi that there are two distinct species, *G. parasitica* and *G. Highlei*, distributed in both North America and Europe.

A fungus found growing on scale insects was described by Petch (5) as a new species of this genus, *Gonatorrhodiella coccorum*. However, the description and illustrations prepared by him for this fungus do not agree with either *G. Highlei* or *G. parasitica*. In fact, no characters could be found in either the descrip-

FIG. 1. A, young conidiophore of *Gonatorrhodiella Highlei* with a terminal head and an intercalary swelling; nodal cells were still attached to the intercalary swelling; B and C, branched conidiophores with several intercalary swellings; some obovate nodal cells are still attached to the terminal heads of the conidiophore in B; D, young conidiophores prior to the formation of intercalary swelling; E, portion of a conidiophore with several chains of conidia (note the difference in size between nodal spore-bearing cells and conidia); F, nodal spore-bearing cell with three chains of conidia.

tion or illustrations of *G. coccorum* that would warrant placing it in the genus *Gonatorrhodiella.* Although he described it as a species of *Gonatorrhodiella,* Petch made the following statement, "Consequently it is doubtful whether this species is correctly referred to *Gonatorrhodiella.*"

Inasmuch as this study of *Gonatorrhodiella Highlei* and comparison of it with other reported species of the same genus have added to our knowledge of its morphology and distribution, it was deemed desirable to amend its original description.

TECHNICAL DESCRIPTION OF GONATORRHODIELLA HIGHLEI A. L. SMITH DESCR. EMEND.

Sterile hyphae hyaline, creeping, septate and branched; conidiophores erect (FIG. 1 A, D), 200–400 μ in height, 12–15 μ in diam.; septate, hyaline, becoming cinnamon buff to clay or rarely tawny in color; simple or rarely branched, swelling into subspherical to ellipsoidal heads, which after maturity may become once or twice proliferous; the proliferations, 18–27 μ in diam., also forming similar proliferating heads, seldom more than five times successively proliferous (FIG. 1 B, C). The conidia, 14–17 $\times$ 9–11 μ, are elliptical and borne in complex trigeminous chains on obovate, nodal cells (FIG. 1 E, F) 16–19 $\mu \times$ 11–17 μ.

Habitat: Associated with *Nectria coccinea* (Pers.) Fries growing with the beech scale (*Cryptococcus Fagi* (Baer.)) on beech (*Fagus grandifolia* Ehrhart) in Maine, North America. Collected originally on onion bulbs in England.

Specimens examined: Collections of *Gonatorrhodiella Highlei,* associated with *Nectria coccinea* and *Cryptococcus Fagi* on beech (*Fagus grandifolia*), were made at least once in the following localities: Maine: *63938,*[4] Perry, T. T. Ayers, Oct. 1933; *67862,* Perry, H. Metcalf and R. P. Marshall, July 27, 1933; *67768,* Liberty, T. T. Ayers, June 28, 1935; *69697,* Liberty, M. L. Lohman, November 15, 1935; *81555,* Topsfield, T. T. Ayers, September 28, 1937; *81556,* Township 22 M. D., T. T. Ayers, September 30,

[4] Numbers, unless otherwise indicated, refer to collections in the herbarium of the Division of Forest Pathology, U. S. Department of Agriculture, New Haven, Conn.

1937; *81557,* Township 39 M. D., T. T. Ayers, September 30, 1937; *81558,* Perry, T. T. Ayers, September 30, 1937.

Doubtful specimen: *Gonatorrhodiella* sp. on *Melannoma pulvis-pyrius* growing on axe chip from *Ulmus americana* L., Indian Town, Maine, H. Eno, October 15, 1936. This form is close to *G. Highlei* but varies slightly from it in morphological characteristics. Further study is necessary before a definite statement can be made concerning its identity.

SPECIMENS OF GONATORRHODIELLA PARASITICA AND G. EXIMIA EXAMINED

The type specimen of *Gonatorrhodiella parasitica* Thaxter, Oct., New Haven, Conn., on *Hypocrea chlorospora.* This specimen is labelled as "type" in Thaxter's handwriting on a pill box containing his collection and is deposited in the herbarium of the Connecticut Agricultural Experiment Station, New Haven, Conn.

Type slide of *Gonatorrhodiella parasitica* deposited in the Farlow Herbarium, Harvard University, Cambridge, Mass.

Cultures of *Gonatorrhodiella parasitica* isolated by Ross W. Davidson (Plant Disease Reported XIX, No. 7, 1935) together with *Trichoderma lignorum* from tissue of malformed sporophores of *Polyporus* sp. (F. P. *59146*) and from river birch decayed by *Fomes* sp.

The type specimen and slide of *Gonatorrhodiella eximia* von Hoehnel deposited in the Farlow Herbarium, Harvard University. Labelled as "H.n. 433 *Gonatorrhodiella eximia* n. sp. Auf *Tremella lutescens* y Carpinus. 23/7.1906. v. Hoehnel, Wiener Wald."

ASSOCIATION OF GONATORRHODIELLA HIGHLEI WITH NECTRIA COCCINEA IN THE UNITED STATES

It is difficult to explain why *Gonatorrhodiella Highlei* has been collected so far in the United States upon only one species of fungus, *Nectria coccinea,* which is considered by some investigators to have been introduced into North America from Europe. Many different species of *Nectria* and other closely related fungi have been collected by numerous investigators throughout New England and New York, but as far as could be learned, *G. Highlei* has never

been found associated with any of them. Furthermore, *G. Highlei* failed to appear in the numerous cultures isolated from the perithecia of these different species of *Nectria* and from cankers with which *Nectria* species were associated. It appeared frequently, however, in cultures isolated from perithecia of *Nectria coccinea* associated with the beech bark disease, and in cultures made from the tissues of beech trees attacked by the same disease. Because of the close association of *G. Highlei* with this particular species of *Nectria,* and the fact that it grows so meagerly when alone on media commonly used for the cultivation of fungi, this fungus appears to be either parasitic or dependent on *Nectria coccinea* for its nutrition. So far, however, no haustoria have been observed in the hyphae of *N. coccinea,* and no other organs to enable *G. Highlei* to act as a parasite have been determined. Similarly, the manner in which *G. parasitica* parasitizes *Hypomyces* sp. and *Hypocrea* sp. was not described by Thaxter (8) although he considered it to be a parasite on these two fungi. He did not report whether he had attempted to cultivate *G. parasitica* without a host on artificial media. Davidson (loc. cit.), however, stated that "An attempt to obtain this fungus [*G. parasitica*] in pure culture failed, although the *Trichoderma* was readily obtained free from the *Gonatorrhodiella. Trichoderma* grows more rapidly than *G. parasitica,* usually covering the entire surface of the agar with a green spore mass before the parasite appears. *G. parasitica* grows slowly over the surface of such a culture and gradually covers it with a 'tawny' red mass of conidiophores and spores."

GROWTH OF GONATORRHODIELLA HIGHLEI IN ARTIFICIAL CULTURE

Initial attempts to obtain pure cultures of *Gonatorrhodiella Highlei* on such common media as potato, potato-dextrose, oatmeal, and malt extract agars were not highly successful, but the fungus grew luxuriantly and produced an abundance of conidiophores on the same media when *Nectria coccinea* was present. Since *G. Highlei* grew so poorly on media containing agar, and because other species of fungi parasitic on insects (6) and on other fungi (2) were found to grow poorly when agar was included in the culture medium, an attempt was made to cultivate *G. Highlei* on substrata without it.

To secure pure cultures of *Gonatorrhodiella Highlei,* single-spore isolations were used at first. However, these conidia failed to germinate on the different media used and even to date the conditions necessary for their germination have not been discovered. Therefore, fragments of the fertile conidiophores were used. These were removed with a fine platinum needle and planted on the agar media. As negative or very slow growth would indicate pure cultures of *G. Highlei* (without *N. coccinea*) the cultures were observed carefully for at least 10 days before they were transferred to the different substrata which were tested as suitable for the growth and sporulation of *G. Highlei.*

As a result of these cultural experiments it was found that *Gonatorrhodiella Highlei* could be grown successfully in pure culture on oatmeal mush (20 grams of oatmeal, 60 cc. of distilled water; autoclaved for 20 minutes at 15 pounds' pressure). On this medium, the fungus grew slowly and covered the surface of the medium within a month, producing an abundance of normal fertile conidiophores. On potato plugs, cooked rice and synthetic malt agar,[5] it produced a trace of vegetative mycelium and a few conidiophores. It formed no conidiophores and only a trace of vegetative growth on potato, potato-dextrose, malt extract, 1% maltose, 1% sucrose, 1% dextrin, 1% proteose-peptone and peptone agar media.

It is interesting to note that this fungus grew and produced numerous fertile conidiophores on these latter media when *Nectria coccinea,* associated with the beech bark disease, *Nectria galligena* Bres. concerned with cankers on various hardwoods, or *Nectria cucurbitula* (Tode) Fries, from conifers was growing in the same tubes. *G. Highlei* failed to grow, however, when either *Nectria cinnabarina* (Tode) Fries, or *N. Coryli* Fuckel was cultured on these same media.

SUMMARY

The presence and distribution of *Gonatorrhodiella Highlei* A. L. Smith, one of the rarer members of the Fungi Imperfecti collected

[5] Formula No. 1579 in Levine, M., and H. W. Schoenlein. A compilation of culture media for the cultivation of microorganisms. Baltimore, Md., 1930.

originally in England on onion bulbs, are reported for the first time in the United States.

G. Highlei is particularly interesting not only because of its unusual morphology, but also because of its association with *Nectria coccinea,* which together with *Cryptococcus Fagi* is concerned with the beech bark disease of our native beech (*Fagus grandifolia*) in New England.

A comparison of *Gonatorrhodiella Highlei* was made with *G. parasitica* and other species of this genus. As a result of these studies, it was concluded that at present there are only two valid species of *Gonatorrhodiella, G. parasitica* and *G. Highlei,* known. Two other species have been described, but *G. eximia* seems to be synonymous with *G. parasitica,* while *G. coccorum* is not a member of the genus.

Gonatorrhodiella Highlei produced only a scant mycelial growth and a few conidiophores on synthetic malt and only a trace of vegetative growth on potato, potato-dextrose, and malt agars. But it grew luxuriantly and produced an abundance of conidiophores on a medium consisting of 20 grams of oatmeal and 60 cc. of distilled water.

When planted with *Nectria coccinea, N. galligena,* or *N. cucurbitula* on potato, potato-dextrose, or malt-extract agar, *Gonatorrhodiella Highlei* grew abundantly and produced numerous fertile hyphae. It failed to grow, however, when it was planted on the same media with either *N. Coryli* or *N. cinnabarina.*

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THE DEVELOPMENT OF A SPECIES OF COPRINUS

G. T. Johnson

(WITH 9 FIGURES)

INTRODUCTION

Schmitz (1842), Hoffmann (1861–1865), de Bary (1866), Brefeld (1877), Levine (1914, 1922), Atkinson (1916), Kühner (1926), and Chow (1931, 1932, 1934) have reported developmental studies of species of *Coprinus*. All of these have agreed that the hymenium is endogenous in origin, that the pilear and stipe primordia are differentiated almost simultaneously very early in development, and in several other details of considerable importance. Reports as to the formation of an annular prelamellar cavity and as to the manner of origin of primary and secondary lamellae differ so greatly, however, that further evidence is required before any claim can be held substantiated. The proper interpretation of these developmental processes is necessary so that a safer basis may be provided for phylogenetic considerations of the Agaricaceae. In this paper the writer records observations on the development of a species of *Coprinus* not previously studied, and in this connection particular attention is given to those details in development over which controversy has arisen.

MATERIALS AND METHODS

The material studied was isolated in 1936 from a sample of Costa Rican soil placed on sterile agar by Dr. C. W. Dodge. The organism subsequently proved readily adaptable for physiological study, since at the time of its isolation a generation of fruit bodies could be produced in nine days on potato-dextrose agar under the proper environmental conditions. Mature specimens fall rather easily into *Coprinus cubensis* Berk. & Curt. according to most of the artificial keys that could be constructed for the genus, but apparently differ from typical material of that species in possessing

brownish rather than whitish scales and slightly more oval spores. A description of the plant follows:

Stipe 1.5–10.0 cm. long, 2–5 mm. thick, equal or slightly attenuated, glabrous, hollow, white, cartilaginous; pileus 1.5–3.5 cm. broad, very thin, campanulate, striate at maturity, grayish, ornamented with brownish scales which partially disappear with age; gills crowded, thin, free, white when young, finally brownish-black, with numerous cystidia; cystidia attached to either or to both gills, 16–49 μ long, 14–24 μ wide, subspherical to cylindrical; basidia 11–16 μ long, 4–6 μ wide, 4-spored; spores $6–7 \times 3–4\ \mu$, smooth, brown to black.

SPECIMENS DISTRIBUTED: G. T. Johnson *n. 625*. Isolated from soil collected at Castilla, Limón Province, Costa Rica.

Sporophores were obtained at varied intervals from flask cultures grown in the laboratory on potato-dextrose agar. The mature fruit bodies were normal in every respect, and in view of the ease with which the organism fruits in culture when isolated from nature there is little reason to suppose that the specimens obtained would present different characters if grown in their native habitat. Plants in every stage of development were selected, killed in Flemming's weaker solution, embedded in paraffin, sectioned, stained, and mounted in balsam.

DEVELOPMENT OF THE ORGANISM

The germ tube emerges from one end of the basidiospore. A single nucleus is present in the mature spore and this soon divides, the two resulting daughter nuclei migrating into the germ tube. As the tube grows and branches, division continues and a large number of free nuclei are finally produced. Septa are not formed for some time after germination. When they do occur no clamp connections are visible and the hyphal cells usually appear multinucleate. Large numbers of oidia may be produced. Clamp connections have never been observed, regardless of the age of the culture.

Buttons are formed laterally on rhizomorph-like clusters of hyphae. Some differentiation has taken place in the earliest stage of development observed by the writer (FIGS. 1, 2). At this stage the center of the button is composed of very compact hyphae; this

mass is the primordium of the fruit body proper. Hyphae of the outer portion terminate in large globose cells which completely surround the button. These cells persist until maturity, when they are gradually shed in the form of " squamules "; they compose the first differentiated tissue, the " blematogen " as defined by Atkinson (**1914**, **1916**).

Stipe, pilear, and hymenial primordia have almost simultaneous origin. The pilear fundament is the most conspicuous, marked by the compact arrangement of hyphae located just below the blematogen in the upper portion of the button. Hyphae of the stipe fundament become loosely interwoven and oriented predominantly in a vertical direction. Pileus and stipe remain in the primordial stage during the formation of the lamellae.

An annular prelamellar cavity can be seen in sections of material of the proper stage killed with Flemming's weaker solution and embedded in paraffin. The cavity develops just below the pilear primordium. In figure 3 it is seen in median section as two clear areas on either side of the young stipe. The hymenial primordium, which was visible as darker staining tissue before the cavity was formed, is now clearly delimited on the upper surface of the cavity. This evidence as to the formation of the cavity agrees with statements of Atkinson (**1916**) but differs from those of Levine (**1914**) for species of *Coprinus*. In 1922 Levine redescribed the method of development that he gave in 1914 (which had been vigorously opposed by Atkinson) as typical of the *Coprini*. Furthermore, he disagreed with the manner of origin of lamellae described by Atkinson, not only for species of *Coprinus* (Atkinson, **1916**) but also for *Agaricus campestris* (Atkinson, **1906**). In Levine's later (**1922**) paper the annular prelamellar cavity mentioned by others and illustrated by figures similar to figure 3 was considered an artifact due to poor fixation. Kühner (**1926**) claimed to have confirmed the method of gill formation described by Levine, but Chow (**1934**), in an extensive memoir on *Coprinus*, supported Atkinson's view and reported that later work by Kühner (unpublished) also did so. It should be noted that Hein (**1930**) has confirmed Atkinson's description of the origin of the lamellae in *Agaricus campestris*.

Observations on this Costa Rican material suggest the following: (1) Atkinson (1916) was correct in describing an annular prelamellar cavity from the examination of normal fixed material. Even Levine (1922) admitted this point, although his earlier

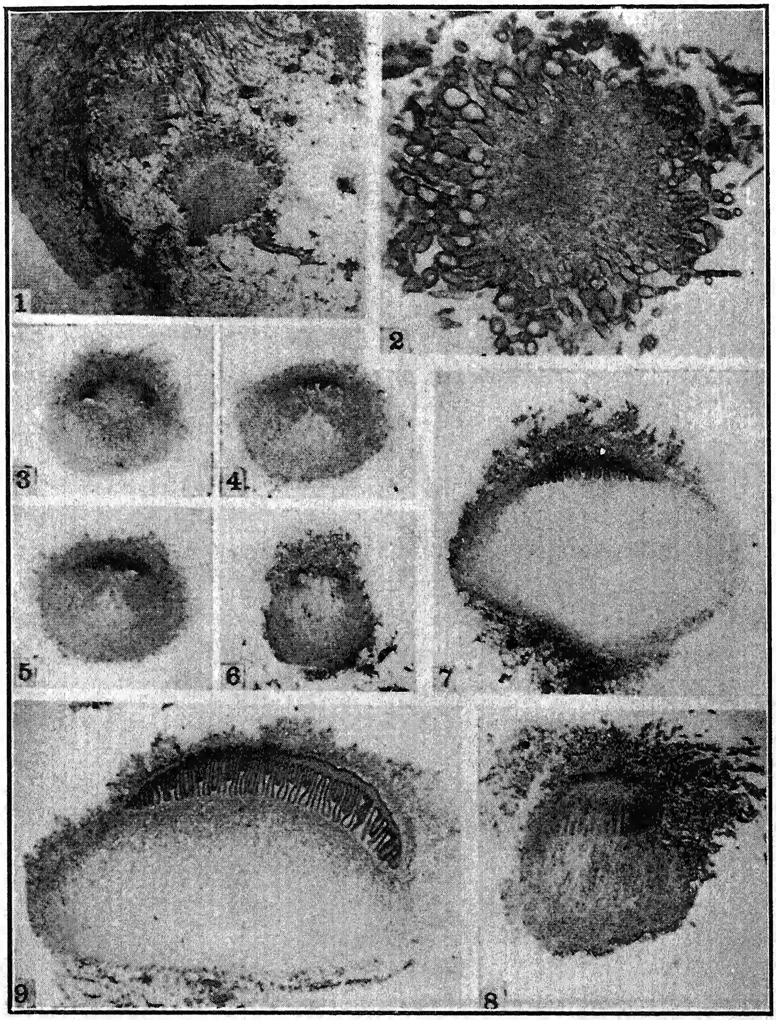

FIG. 1, two sporophore primordia; 2, sporophore primordium; 3–5, young sporophores with normal lamellar development; 6 and 8, young sporophores with abnormal lamellar development; 7 and 9, sporophores more advanced in development. Magnifications approximately as follows: fig. 2 × 200; all others × 50.

(1914) paper, during the preparation of which he evidently did not see such a cavity, was based upon material killed by similar reagents. (2) Levine (1922) finds strong support for his theory, that the lamellae ultimately develop on each side of a series of gill cavities, in sections of dead buttons. In culture very few buttons finally produced sporophores. There is no doubt but that Levine's description applies to a large number of these cases. Their structure appears quite different from that of similar material fixed in the living condition and an annular prelamellar cavity is never formed. Figures 6 and 8 illustrate the structure of such buttons in vertical section. The plants from which these sections were made were removed from agar cultures fifteen days old on which the buttons had been visible since the sixth day. Several mature fruit bodies had been produced by the same cultures. In normal buttons, however, the lamellae develop shortly after the formation of the annular prelamellar cavity (FIGS. 4, 5, 7, 9). Atkinson emphasized the fact that the trama of the lamellae is formed from tissue growing down from the pilear fundament into the lamella. This does occur, and it gives collaborative support to the opinion that an annular cavity normally exists in species of *Coprinus*.

Other changes now take place: (1) the lamellae grow toward the bottom of the cavity and become loosely attached to the stipe; (2) the hyphae in the stipe primordium form compact vertical rows of very short cells; (3) a single layer of highly differentiated cells is formed just below the upper blematogen; (4) the central portion of the stipe autolyses and that structure is, therefore, hollow at maturity.

All elements increase in size simultaneously. Growth of the stipe is exceedingly vigorous, taking place primarily through elongation of the primordial cells. The expansion bursts the blematogenous layer and the plant assumes the appearance of a mature sporophore, with its hymenium exposed to the air. The blematogen breaks up into small flocculent masses which are gradually shed from the outer pilear surface. Spores are formed and the lamellae deliquesce in the manner typical of species of *Coprinus*.

DISCUSSION

According to Atkinson there are two general patterns of development through which lamellae endogenous in origin are formed. In one of these (the *Agaricus* type) the lamellae arise as downward folds of an annular prelamellar cavity; in the other (the *Amanita* type) a series of gill cavities is produced, hymenial elements being formed on the sides of each cavity. Both Levine (1922) and the writer have observed sections of young buttons of *Coprinus* which indicate that conditions simulating either type of development may be present in one species. If, as Atkinson implies, the two types of development are so distinct as to indicate phylogenetic lines, it is important that extreme care be taken in interpreting sections of material of this kind. In the species of *Coprinus* which he has studied the writer believes that an annular prelamellar cavity is formed in the buttons that give rise to mature sporophores, but that abnormalities in development often result. In the abnormal cases such a cavity is never formed, and the buttons in section often appear similar to those from which Atkinson described the "*Amanita*" type of development. The possibility that similar observations could be made on other genera and species should be borne in mind.

Coprinus tomentosus Fries (Chow, 1932, 1934) is evidently the only investigated species to which the organism studied is closely related. Both lack clamp connections and have the ability to fruit in single spore culture. Furthermore, striking similarities may be seen in the arrangement of the cystidia and in the manner of development of the sporophore.

SUMMARY

(1) This paper describes the developmental morphology of a species of *Coprinus* close to, if not identical with *C. cubensis*. The organism was isolated from Costa Rican soil and is particularly adaptable for physiological study.

(2) At the time of its isolation from natural conditions this organism will fruit in flask cultures on potato-dextrose agar in nine days under the proper environmental conditions.

(3) Stages in the development of the fruit body are similar to those of other investigated species of the genus.

(4) Examination of the buttons that would have produced typical sporophores reveals an annular prelamellar cavity and the lamellae of such buttons originate in the manner described by Atkinson for other *Coprini*.

(5) Some of the buttons that never mature in agar cultures apparently do not form an annular prelamellar cavity and lamellae are not differentiated in the same manner as in the normal button. The writer believes that these are abnormalities which have resulted from the conditions that failed to bring about the production of normal sporophores.

(6) The developmental study of this species indicates its close relationship to *Coprinus tomentosus*.

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FURTHER NOTES ON FUNGI [1]

S. M. Zeller

(with 17 figures)

Notes and descriptions are presented herewith on several new species of fungi or those deserving special notice at present. These are mostly Gasteromycetes but a new species of *Endogone* is also included.

I wish to thank Mrs. D. P. Rogers for the careful illustrations of some of the new species, and Dr. D. P. Rogers for editing the Latin diagnoses.

1. **Rhizopogon brunnescens** sp. nov.

Fructificationes parvae circa 1–1.5 cm. crassae, subsphericae vel elongatae, superficie hebeti, laevi, coactili, alba vel rosea, cinnamomeo-brunnescenti; fibrillis paucis; peridio 600 μ crasso, strato externo hyphis obscure brunneis implicatis, interne prosenchymate et parenchemati pallido-brunneis intermixtis; gleba alba vel sublutescenti; septis modice crassis; basidiis cylindro-clavatis, 4-sporigeris; sporis anguste ellipsoideis vel oblongis, subhyalinis, 6.8–7.5 × 2.5–3.1 μ.

Fructifications small, 1–1.5 cm. in diameter, subspherical to elongate; surface dull, even, felty, white to pinkish when fresh oxydizing cinnamon-brown; fibrils scanty; peridium duplex, outer layer of dark-brown interwoven hyphae, inner of lighter brown prosenchyma and parenchyma intermixed, 600 μ thick; gleba white and remaining so or only slightly buffy at maturity; septa moderately thick; basidia cylindro-clavate, 4-spored; spores narrowly ellipsoid or oblong, subhyaline, 6.8–7.5 × 2.5–3.1 μ.

In coniferous duff, Horse Camp, Mt. Shasta, California, collected by *Wm. B. Cooke,* July 5, 1939, Nos. *13305* and *13306.*

2. **Rhizopogon villosulus** sp. nov.

Fructificationes parvae, usque ad 1.5 cm. crassae, subglobosae, rhizomorphibus magnis affixae; superficie villosula, molli, brunnea, rimoso-are-

[1] Published as Technical Paper No. *353,* with the approval of the Director of the Oregon Agricultural Experiment Station. Contribution from the Department of Botany.

olata; peridio tenui, siccitate 32–60 μ crasso, strato externo hyphis magnis, 4–7 μ crassis, laxis, brunneis composito, rimoso, strato interno hyphis compactis hyalinis constito; gleba pallido-brunnea, siccitate luteo-brunnea; locellis parvis, labyrinthiformibus; septis angustis hyphis magnis gelatinosis compositis, paraphysibus obovoideis vel oblongis, gelatinosis, 12–20 × 8–10 μ; basidiis anguste clavatis, 2- vel 4-sporigeris, 14–25 × 3–5 μ, sterigmatibus circa 1–1.5 μ long.; sporis anguste ellipsoideis, subhyalinis, 6–7.5 × 2.2–2.7 μ.

Fructifications small, up to 1.5 cm. in diam., subglobose, from a large rhizomorph; surface soft, slightly villose, brown (bister) when fresh, changing little when dried, often becoming areolate due to the rupture of the outer peridium; peridium very thin, 32–60 μ thick, when dry, duplex, the outer layer of large, 4–7 μ, brown loose hyphae some of which are somewhat erect, sometimes rupturing and exposing the inner layer which is composed of hyaline compactly woven hyphae; gleba light brown, drying buffy brown; cavities small, labyrinthiform; septa narrow, of large highly gelatinized hyphae; paraphyses obovate to oblong, highly gelatinized, 12–20 × 8–10 μ; basidia narrow clavate, 2- and 4-spored, exceeding the paraphyses, 14–25 × 3–5 μ; sterigmata about 1–1.5 μ long; spores narrowly ellipsoid, slightly colored, 6–7.5 × 2.2–2.7 μ.

In duff under conifers, Hat Point along Snake River canyon, 23 miles above Imnaha, Wallowa county, Oregon, *H. M. Gilkey,* July 26, 1939, *type, A. M. Rogers,* July 26, 1939.

3. **Hymenogaster minimus** sp. nov.

Fructificationes minutae, circa 2 mm. crassae, globosae, albidae, colore tinctae locellarum brunnearum per peridium pellucidum se ostentarum; basi sterili parum insigni; peridio circa 80 μ crasso, hyalino, hyphis septatis, 7.5–9 μ crassis, laxe implicatis composito, gleba locellis paucis labyrinthiformibus; basidiis 2- vel 4-sporigeris, clavatis, 10–12 × 5–6 μ, sterigmatibus brevibus; sporis obscure brunneis, tenuiter verrucosis, utriculo hyalino, stricto vestitis, lato-ellipsoideis, apiculo parvo, 14–16.3 × 11.5–13 μ.

Fructifications tiny, about 2 mm. in diameter, globular, translucent whitish, with the dark-brown color of the spores showing through from the cavities within and more whitish over the septa of the gleba; peridium about 80 μ thick at the thinnest places when fresh, hyaline, a mesh-like network of septate hyphae, 7.5–9 μ in diameter; sterile base barely apparent as a translucent spot below; no columella or main veins apparent; gleba made up of several labyrinthiform cavities; basidia 2- and 4-spored, clavate, 10–12 × 5–6 μ; sterigmata very short; spores very dark-brown (umber), finely verrucose, covered with a closely applied, hyaline utricle, broadly ellipsoid with a small apiculus, 14–16.3 × 11.5–13 μ.

In coniferous duff, along Trout Creek (tributary to Molalla River), Clackamas county, Oregon, *Beulah G.* and *Helen M. Gilkey,* June 16, 1939, type (in Zeller Herb.).

Hymenogaster minimus is slightly larger than *Gasterella lutophila* and the spores are similar in ornamentation. However, the spores of *Gasterella* are rougher and are without the utricle. The fructifications of *H. minimus* are so small and translucent that the orientation of all cavities and other parts may be observed when halves in water are examined under a low power binocular. The gleba has about 6–14 labyrinthiform cavities, irregular in shape and arrangement. In this latter respect *H. minimus* differs from *Gasterellopsis* Routien, which is about the same size but in which the cavities are arranged symmetrically around a columella as an axis, similar to the carpels of " Cheeses " (*Malva rotundifolia*).

4. HYMENOGASTER REMYI Zeller & Dodge.

Recently the collection of fresh specimens of this species came to us from Wm. B. Cooke, on Mt. Shasta, California. As soon as we saw the spores of the Shasta material we were reminded of the type from the high Alps of Europe. An actual study again of the type, which was kindly loaned from the Farlow Herbarium by Dr. D. H. Linder, shows them to be identical, but fresh material shows also some characters not seen in dry material. An emended description follows:

Fructifications depressed-globose, 2.5–3 cm. broad, 1.5–1.7 cm. high, dingy pale yellow, drying whitish or isabelline, surface smooth, dull, fibrils not evident and no sterile base; peridium 410–460 μ thick, drying 100–270 μ, composed of large compact, or loosely interwoven, thin-walled, hyaline hyphae, about 10–14 μ in diameter; gleba Argus brown to Brussels brown; septa stupose, 30–35 μ thick, hyaline, somewhat gelified; cavities medium size; basidia clavate to pyriform, 4-spored; spores obovoid, rounded above, with a loosened utricle and verrucose, with distal end quite warted and appearing " crowned " under low power microscope, smooth to slightly wrinkled on sides, young spores smooth, obovoid to almost spherical, 8–11 $\times$ 5.5–7.5 μ.

In duff under a log of *Abies magnifica* var. *shastensis,* elevation 8000 ft., woods northwest of Horse Camp, Mt. Shasta, California.

July 31, 1939, *Wm. B. Cooke,* No. *13376,* and the type collected by *Monseur Remy* at Briançon, France, in 1923. This species should be looked for in other alpine regions.

5. **Dendrogaster elasmomycetoides** sp. nov.

Fructificationes turbinatae, 3–4 cm. crassae, 2.3–3 cm. altae; superne viscidissimae glabraeque, inferne glabrae, albogriseae, siccitate superne pallido-luteae, inferne purpureae, fulvescentes; basi sterili conica sursum in columellam stipitoidem crassam percurrentem procurrenti, extus et intus albida, prosenchymate et parenchymate constita; peridio 260–350 μ crasso, strato externo prosenchymato gelatineo, interno parenchymate collapso composito; gleba luteo-brunneola, locellis parvis, globosis vel labyrinthiformibus; septis reticulato-prosenchymatis, hic illic parenchymate compositis; basidiis anguste clavatis, 4-sporigeris, sterigmatibus circa 2–3 μ longis; sporis brunneis, lato-obovoido-ellipsoideis, verrucosis, utriculo tenui, hyalino, stricto vestitis, 10–11.5 $\times$ 8–9.5 μ; textis sterilibus omnibus cum hyphis lactiferis, sed lacte non viso.

Fructifications turbinate or shape of a young agaric before breaking the veil, 3–4 cm. in diameter, 2.3–3 cm. high, greatly shrinking when dry, extremely viscid and even above, smooth below, whitish-gray drying light-buff above, purplish becoming tawny below (FIG. 14); sterile base a conical projection, extended above as a broad percurrent stipe-like columella, whitish within and without, prosenchymatous with islands of parenchyma and hyaline food ducts dispersed; peridium 260–350 μ thick, the outer ½ to ⅔ of which is composed of a gelatinous periclinal prosenchyma and the inner ⅓ to ½ of a more compact (dark staining) collapsed parenchyma (?); gleba slightly more buffy-brownish than the sterile tissues, cavities small, globose to labyrinthiform; septa a meshy prosenchyma, here and there parenchymatous; basidia narrowly clavate, 4-spored; sterigmata about 2–3 μ long; spores brown, broadly obovoid-ellipsoid, verrucose, 10–11.5 $\times$ 8–9.5 μ with a thin, almost hyaline, closely applied utricle (FIG. 15); no milk but brown ducts in all sterile tissues.

Two inches under duff of *Abies magnifica* var. *shastensis,* Horse Camp, Mt. Shasta, Siskiyou county, California, *Wm. B. Cooke,* No. *10,216,* type, July 18, 1938. Elevation 8000 ft.

The collector's notes which follow are of interest. "This specimen looked at first like the bud of an agaric of some sort but when I sliced it in two I found it was not. I washed the dirt off and in so doing found that the outer layer became exceedingly viscid and slimy in my hands. At a point where one might say

the stipe ends and the columella begins, or if it were an agaric, where the pileus would eventually break away from the stalk leaving the veil or volva, was an area colored on the outer layers of the fructification with a purple color. The rest of the fructification was rather pallid on the outside, being of a more or less white-gray color. There was no marked coloration inside, no change of color when bruised, no milky exudation."

It is rather perplexing to a taxonomist of the Gasteromycetes to find such a fungus as *Dendrogaster elasmomycetoides*. It could be, by the stretch of imagination, placed in any one of three genera. I am not entirely sure that my choice is the best. Perhaps a less conservative worker would erect a new genus for it. To aid him we might give these additional suggestions. This fungus has the form and some internal morphological characters of *Elasmomyces*. It has the spores of *Hymenogaster,* and although the collector says there was "no milky exudation" when fresh, there are nevertheless a very few very dark-brown ducts in the sterile tissues and it may be that at certain stages of development of the fructifications these ducts are lactiferous. It therefore might be placed in *Arcangeliella* along with *A. Behrii* and its so-called variety *caudata*. The writer, however, has decided in favor of *Dendrogaster* because of the character of the spores, columella, and the fact that the collector indicated no milk when fresh. He is also inclined after more recent study to the transfer of *Arcangeliella Behrii* and its variants to the genus *Dendrogaster*. The more knowledge we have of the Gasteromycetes the more the evolutionary trends within the group become anastomosing lines.

Young spores of *D. elasmomycetoides* are more or less truncate at the distal end with the utricle bulged or blister-like over the flat portion.

6. **Hydnangium oregonense** sp. nov.

Fructificationes 1–2 cm. crassae, depresso-globosae, superficie laevi, albae vel brunnescentes; peridio 110–175 μ crasso, strato externo 35–45 μ crasso, pseudoparenchymato, interno hyphis periclinis et implicatis composito; gleba alba carneo- vel brunneo-rubescenti; locellis parvis; septis hyphis laxis implicatis; cystidiis moniliformibus; basidiis clavatis, 1-sporigeris, 30–37 $\times$ 10–12.5 μ, sterigmatibus 18–25 μ longis; sporis subhyalinis, echinulatis, aculeis 2.5–6.3 μ longis, lato-ellipsoideis, 16–17.7 $\times$ 14.4–15 μ (sine aculeis); odore farinaceo.

Fructifications 1–2 cm. broad, depressed globose, smooth, white becoming marbled with light and dark-brownish spots; peridium 110–175 μ thick, duplex, outer 35–45 μ of pseudo-parenchyma, inner layer of periclinal and interwoven hyphae; gleba white becoming flesh-pink, then brownish-pink; cavities small; septa of loosely woven hyphae; cystidia moniliform when present, exceeding the paraphyses 13–20 μ; basidia clavate, 30–37 × 10–12.5 μ, 1-spored; sterigmata long, stout, 18–25 μ long before spore formation, becoming shorter with spore formation; spores almost hyaline, sharply echinulate (echinulae 2.5–6.3 μ long), broadly ellipsoid, 16–17.7 × 14.4–15 μ without echinulae; odor farinaceous.

Under forest duff in mixed woods, Roaring River Fish Hatchery, Linn county, Oregon, April 30, 1938, *S. M. Zeller, 8487,* type.

This is a most interesting species of *Hydnangium,* closely related to *H. monosporum* Boud. & Pat. It differs from that species, however, in peridial structure and spore characters. In young specimens without spores the moniliform cystidia are very plentiful in certain cavities of a specimen; other cavities will have none. In older stages where spores are just beginning to form certain cavities near the peridium are lined with hymenium having so many mono-sterigmate basidia that they appear setose under the low power microscope. These sterigmata without spores are stout, obtuse, and 18–25 μ long. In cavities near the center of such fructifications where spores are mature these straight seta-like sterigmata are entirely lacking, each bearing a spore.

7. **Hysterangium aureum** sp. nov.

Fructificationes subsphaericae vel depresso-globosae, usque ad 1.3 cm. crassae, firmae, aureae; columella mediam fructificationem attingenti, leviter ramosa; peridio 325–450 μ crasso, non facile separabilibus, parenchymato, cellulis polyedricis usque ad 72 μ crassis extus aureis, intus hyalinis; gleba brunneo-olivacea, locellis magnis, aliquentum e columella radiantibus, vacuis; septis hyalinis, circa 80 μ crassis, gelatinescentibus; sporis ellipsoideis, utroque rotundatis, hyalinis, 11–12.5 × 5 μ.

Fructifications subspherical becoming depressed-globose, up to 1.3 cm. in diameter, firm, golden-brownish, drying darker; columella reaching to center of fructification, somewhat branched; peridium 325–450 μ thick, not easily separable, parenchymatous, of polyhedral cells up to 72 μ in diam., outer cells golden, inner hyaline, no distinct layer of hyphae separating peridium and gleba; gleba brownish-olivaceous; cavities large, somewhat radiating;

empty; septa hyaline, about 80 μ thick of gelified hyphae; spores ellipsoid, rounded at both ends, hyaline, 11–12.5 $\times$ 5 μ.

Under vine maple and conifers, Trout Creek Recreational Area, Linn county, Oregon; collected by *S. M. Zeller,* No. *8480,* type, May 21, 1936.

8. HYSTERANGIUM CRASSUM (Tul.) Fischer.
(Syn. *H. clathroides* var. *crassum* Tul.)

Fructifications enveloped in a dense spawn of slender white, much branched rhizomorphs, up to 1.8 cm. in diameter, surface white becoming a warm brown, cottony with rhizomorphs and hyphae which adhere everywhere; peridium 70–110 μ thick, easily removed, composed of a layer of compact, heavy-walled prosenchyma of cells up to 6 μ in diameter, overlaid outside with hyphae about 3–3.8 μ in diameter with some clamp-connections and sometimes covered with white crystals, and prosenchyma lined inside with a thin layer of soft parenchyma extremely variable in thickness, extending into interstices of the interrupted tramal peridium; columella much branched; gleba glaucous-virescent, becoming greenish-ashy and even clay-color, very dark-greenish in preservative; septa variable in thickness of intertwined, hyaline hyphae about 3.2 μ in diameter; cavities medium radiating; basidia narrowly clavate, 2–3-spored, early evanescent; spores sessile, olivaceous, fusiform acute or obtuse above, sometimes papillate, epispore thick, 17.5–20 $\times$ 5–6.3 μ; odor unpleasant at maturity.

In a dense spawn 2–4 inches under forest duff. Usually under maple, oak or conifers.

The writer has been interested for a number of years in the habitat and general characters of this species as it occurs under natural conditions. After once seen in the forest soil it cannot be mistaken a second time. The heavy white spawn (so well illustrated by Tulasne, *pl. 2, fig. 2*) is found under the forest duff. It is usually 2–4 inches thick and may spread through the soil for several feet. The spawn may be taken out in large pieces and the fructifications literally "peeled" or "shucked" out of the spawn, which is a compact meshiness of tiny white rhizomorphs and mycelium. It is most usually found in gravelly soil or in mountain soils where there is much rather finely crushed rock.

It is evident this species is not even closely related to *H. separabile* (*H. clathroides* of Tulasne, Hesse, and Zeller & Dodge), and

Fischer (Schweiz. Zeits. Pilzk. **16**: 103–105. 1938) was justified in raising it to specific rank.

Many collections of *H. crassum* particularly from Oregon and California have been examined since those previously cited (Ann. Missouri Bot. Gard. **16**: 97. 1929) but space will not be given here to cite individual collections.

9. **Hysterangium separabile** sp. nov.

Fructificationes 1–1.5 cm. crassae, globosae, albae, brunnescentes; superficie glabra; superne funiculi desunt, inferne inconspicui; columella vulgo magna prominentique, mediam fructificationem attingenti vel a basi ramosa; peridio 220–450 μ crasso, parenchymato, cellulis sphericis vel polyedricis, 12–40 μ crassis strato interno tenui, hyphis parvis, parallelis facile separabilibus composito; gleba viridi, siccata pallide vel obscure virido-olivascenti, locellis parvis, vacuis, polydericis vel irregularibus, aliquentum e columella radiantibus; septis 85–140 μ crassis, hyphis laxe implicatis circa 5–7 μ crassis compositis, gelatin escentibus; basidiis longis, irregulariter cylindericis, 3–4-sporigeris (vulgo 3-sporigeris), sterigmatibus vel brevibus vel 16–18 μ long.; sporis olivaceis, lanceolatis, 12–19 × 6–8 μ, episporo crasso, subrugoso laxoque, subinde papillatis; maturis odore foetido; sapore grato junioribus.

Fructifications up to 1.5 cm. in diameter, globose, becoming very irregular on drying, white when young becoming pale ochraceous-buff or light ochraceous-salmon when fresh, becoming buff-pink to onion-skin pink where bruised, drying ochraceous tawny to mummy-brown; fibrils none above, but variable from terete and free to innate or appressed below; columella usually large and prominent, reaching half way to apex of fructification or often branching near the base; peridium 220–450 μ thick, parenchymatous, the cells spherical to polyhedral, varying from 12–40 μ in diameter with a very thin filamentous layer between the parenchyma and gleba, easily separable; gleba green when fresh, becoming citrine drab or grayish-olive to dark greenish-olive on drying; cavities polyhedral to irregular, with a tendency to radiate from the columella, small, empty; septa 85–140 μ thick, composed of large, thin-walled, loosely woven hyphae, up to 5–7 μ in diameter, finally becoming highly gelatinized; basidia long, irregularly cylindrical, 3–4-spored (mostly 3-spored); sterigmata usually short, although sometimes becoming 16–18 μ long; spores acrogenous, olivaceous in mass, lanceolate, 12–19 × 6–8 μ (averaging 15.3 ± 0.9 μ long), with a thick epispore which sometimes is slightly roughened and becomes loosened in age, sometimes papillate at apex; odor offensive at maturity; taste pleasant when young.

Hypogeous under conifers and deciduous trees and shrubs. It has a wide distribution in the New England States, New York,

Wyoming, Arizona, Oregon, and California; Chile and Argentina in South America, and in Europe.

Hysterangium separabile is the name proposed for that species which has gone erroneously under the name of *H. clathroides* ever since the time of Tulasne.[2] The concept persisted through publication by Hesse, Buckholz, and Ed. Fischer, until recently when the latter studied Vittadini's type of *H. clathroides* and found it to be distinct. For the most part therefore the citations of specimens under the name *H. clathroides* in a previous publication (Ann. Missouri Bot. Gard. **16**: 95–96. 1929) apply to *H. separabile.* Since 1929 many collections of this species have been received from various localities and many have been found in Oregon but space will not be given to their citation here. The following large collection of both dried and preserved material is designated as the type of *H. separabile:* Oregon, Linn county, Trout Creek Forest Camp Recreational Area, May 21, 1938, *S. M. Zeller,* No. *8479,* type.

The peridium of this now historical species is almost entirely parenchyma. There is, however, a very thin layer of very fine, hyaline hyphae lining the inside of the parenchyma. The outer surface of the parenchymatous layer oxidizes at a rather early stage, becoming brownish and the smaller cells in this region may be found collapsed and may easily be mistaken for hyphae. The character of the surface is one distinguishing feature separating it from *H. affine.*

10. HYSTERANGIUM SETCHELLII Fischer, Ber. Schweiz. Bot. Ges. **48**: 33. 1938.

Fructifications subglobose, 0.5–1.5 cm. in diam., from abundantly branched, white mycelium; surface finely scurfy, brownish in preservative; peridium easily separable, 110–180 μ thick, of very compact, large gelatinous hyphae, the very thin splitting layer next to the gleba of much finer texture; gleba cartilaginous, dull slaty color, with broad milk-white septa, which radiate, scarcely branching from the center of the fructification to the peridium, and form an interrupted, more or less thick tramal peridium; columella prominent, white, reaching ½ to ⅔ to summit of fructification, scarcely branched except for the large septa (above); cavities relatively small, elongate, narrow, radiating; spores brownish-olive, fusiform, 14–19 $\times$ 5–6 μ.

[2] See reference to Fischer under *H. crassum.*

In duff under *Quercus densifolia,* Sunset Park, Santa Clara county, California, May 17, 1903, *N. L. Gardner,* No. *146,* type (in Univ. of Calif. Herb.).

The type of this species was loaned to the writer through the kindness of Dr. Lee Bonar. An amended description is presented above. The peridium of *H. Setchellii,* although evidently of a fundamental (primary) filamentous type, is so compact it might easily be construed by some as prosenchyma. The hyphae, however, are so parallel that the peridium is essentially filamentous.

In *H. Setchellii* and *H. crassirhachis* we have another pair of species illustrating the extreme parallelism between the two distinct groups of species in the genus *Hysterangium.* Our late colleague, Dr. Ed. Fischer, pointed out in his discussion of *H. Setchellii* the primitive nature of the species, a possible transition form from *Gautieria,* but on the other hand also its similarity to *H. crassirhachis,* a representative of that group of species having a pseudoparenchymatous or hymenial peridium. Several distinct pairs of species illustrate the strict parallelism between these two groups of species. For instance, to mention those with primary peridium first in each case, there are *Hysterangium Darkeri* Zeller and *H. Phillipsii* Harkness, *H. Fischeri* Zeller & Dodge and *H. affine* Massee & Rodw., *H. cistophilum* (Tul.) Zeller & Dodge and *H. separabile* Zeller, and *H. Setchellii* Fischer and *H. crassirhachis* Zeller & Dodge. If the one group is to be considered more primitive than the other it would seem necessary also to consider that the pairing species in the parallel line having hymenial peridium did not lag far behind the original line of development in the genus. In this connection it should be stated that there are many intermediate species in which the primary peridium persists along with the hymenial peridium.

If Fischer's contention is correct and a so-called hymenial peridium of parenchyma indicates a higher developmental stage in the phylogeny among the species of the genus *Hysterangium,* should one not look for a predominance of such structures in so-called higher families such as *Protophallaceae* and *Clathraceae* on the one hand and *Gelopellaceae* and *Phallaceae* on the other? This is not the case, however; the peridial structure in most of the genera of these families is primary.

It might perhaps be more logical to consider that there may be several lines of development within the genus *Hysterangium,* and that species having a spore magnitude similar to genera above and below may be considered within the most direct line of development. Such a concept would place *Hysterangium Darkeri* in the key position among the species of the genus with *H. Phillipsii* having closest affinities as to spore size and characters. The direct line would therefore be from *Protogaster* through *Rhizopogon* to *Hysterangium Darkeri,* thence to the *Protophallaceae* and *Clathraceae.* There must be some unknown steps between *Hysterangium Darkeri* and the *Gelopellaceae,* but the final connection seems logical.

11. **Leucogaster levisporus** sp. nov.

Fructificationes circa 2.5 cm. crassae, globosae vel irregulares, creteo-albae, griseolescentes; funiculis non raris; peridio 100–120 μ, siccitate 25–50 μ crasso, e parenchymate e cellulis hyalinis, polyedricis, composito; gleba alba, locellis maturis a sparis farctis; septis prosenchymatibus, circa 30–45 μ crassis; basidiis clavatis, longis, superne 6–7 μ crassis, 4-sporigeris, sterigmatibus usque ad 22.5 μ longis, 2.5 μ latis; sporis hyalinis, sphericis vel ellipsoideis, 10–12.5 μ crass., levibus, episporo 1.2–1.5 μ crasso, utriculoque gelatinoso, 0.6–0.75 μ crasso vestitis; conidiis levibus, hyalinis, ellipsoideis, ceterum ut basidiosporis.

Fructifications up to 2.5 cm. in diameter, globose to irregular, chalk or milky-white becoming grayish; fibrils rather abundant; peridium 100–120 μ thick, drying 25–50 μ, composed of hyaline thin-walled parenchyma of polygonal cells which collapse on drying; gleba white, lacunae filled with spores at maturity; septa prosenchymatous, about 30–45 μ thick; hymenium of long-pedicelled basidia and conidiophores; basidia clavate of various lengths, 6–7 μ broad above, 4-spored; sterigmata of various lengths, up to $22.5 \times 2.5\ \mu$; spores hyaline, spherical to ellipsoid, 10–12.5 μ, smooth with an epispore 1.2–1.5 μ thick, covered by a gelatinous sheath about half as thick; conidia on long simple conidiophores, smooth, hyaline, and epispore as in basidiospores, ellipsoid.

In coniferous forest duff, Hat Point, 23 miles above Imnaha, Wallowa county, Oregon, *A. M. Rogers,* July 26, 1939, type.

Leucogaster levisporus is distinguished by the smooth spores and parenchymatous peridium.

12. **Leucogaster magnatus** (Harkness) comb. nov.
(Syn. *Leucophlebs magnata* Harkness.)

Fructifications up to 3 cm. in diameter, subglobose or elongate, white to ochraceous, smooth: peridium 120–150 μ thick, composed of fine, thick-walled, closely woven hyphae, white; gleba white, the freshly cut surface often showing a blue tint which soon vanishes, cavities decreasing in size toward the surface, sometimes full of cobwebby hyphae like a capillitium, often filled with spores; septa thin, homogeneous, 60–80 μ thick, composed of closely woven, hyaline hyphae; chlamydospores borne terminally on long slender branches of the cavity hyphae, hyaline, spherical, with very fine beaded echinulae, enclosed in a gelatinous sheath, 13 μ in diam.; basidia pyriform at tip, various lengths, 2- and 4-spored; basidiospores same in appearance as chlamydospores; peculiar odor.

Under conifers and broad-leaved trees. Western Oregon and California.

Specimens examined in addition to those previously reported:

Oregon: Benton county, Alsea Mt., Dec. 10, 1938, *Dr.* and *Mrs. D. P. Rogers* (in Zeller Herb. *8511, 8513*); 6 miles SW of Philomath, Nov. 11, 1939, *Max Doty.*

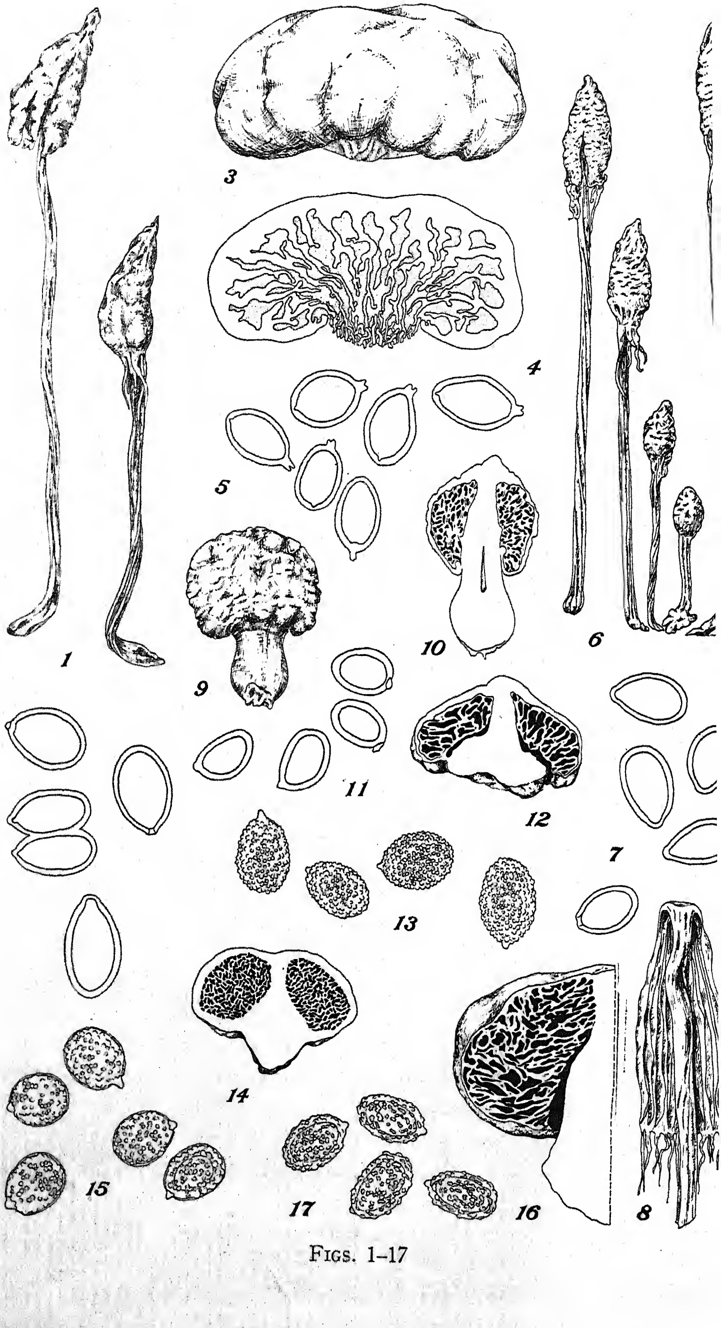
California: *H. E. Parks,* No. *37b* (sent in as *L. citrinus*).

13. **Secotium eburneum** sp. nov.

Fructificationes 1–1.5 cm. altae, 2.5 cm. crassae; pileo crasso-turbinato, 2.5 cm. crasso, 1–1.2 cm. alto; superficie laevi glutinosa, eburnea; stipite conico, inferne crasso superne in columellam crassam percurrentem procurrenti, solido, albo; peridio superne circa 1 mm. crasso, inferne tenuo e stipite separabili; gleba gilva, locellis parvis, e columella leviter radiantibus; sporis fusco-brunneis, leviter verrucosis, ellipsoideis vel ovoideis, 13–15 × 8.7–10 μ.

Fructifications 1–1.5 cm. tall, 2.5 cm. broad; cap broadly turbinate, 2.5 cm. broad, 1–1.2 cm. high (FIG. 12); surface smooth very slimy, viscid, pure glistening white; stipe hardly exceeding the cap below, conical, percurrent with broad bulbose base, solid, white throughout; peridium about 1 mm. thick above, thinner below; gleba gilvous, cavities small with a radiating tendency; basidia not seen; spores dark-brown, very slightly roughened, ellipsoid to ovoid, 13–15 × 8.7–10 μ (FIG. 13).

Under duff of White Pine, Monument Peak, Linn county, Oregon, *Helen M. Gilkey,* June 8, 1940, type.



FIGS. 1–17

14. **Secotium longipes** sp. nov.

Fructificationes 11–14 cm. altae, aliquantulum tenuibus; pileo 3–4 cm. longo, ad basim 1–2 cm. crasso, oblongo-ellipsoideo vel acute conico, apice acuminato, basi truncata, fibrillis longis decurrentibus ornata, superficie glabra, inferne in longitudinem striata vel subrimosa, pallide lutea, siccitate pallida vel obscure brunnes; stipite 2–2.5 mm. crasso, tereti, aequo cavo vel farcto, tenaci, glabro vel substriato, inferne subfibrilloso, concolori, ad basim fuscescenti; gleba fusco-brunnea, locellis magnis, elongatibus perumque e stipite radiantibus; cystidiis magnis, oblongis; sporis fuscis, laevibus, ovoideis vel ellipsoideis, episporo crasso, 11–14 × 6–8.5 μ.

Fructifications, 11–14 cm. tall, rather slender (FIG. 1); pileus 3–4 cm. long, 1–2 cm. broad at the base, oblong-ellipsoid to narrowly conical, apex sharply acuminate, base truncate with long decurrent fibrils which are lighter than the pileus, surface smooth, appearing somewhat longitudinally striate below, becoming somewhat rimose, yellowish-buff, drying lighter or dark-brown where bruised; stem 8–10 cm. long below pileus, 2–2.5 mm. diameter, terete, equal, hollow or stuffed, tough, smooth to slightly striate, slightly fibrillose below, concolorous, darker at the foot; gleba raw umber, coarsely cellular, cells elongate separated by thin anastomosing lamellar partitions; cystidia large, oblong; spores dark brown, smooth, ovoid to ellipsoid with thick epispore, with germ-pore at distal end, sometimes conjugating laterally, 11–14 × 6–8.5 μ (FIG. 2).

Scattered, on soil in marshy alpine meadow along creek, under *Ceanothus velutinus* and *Prunus emarginatus*, elevation 5700 ft., on south slope of Mt. Shasta, Siskiyou Co., California. July. Collected by *Wm. B. Cooke*, Nos. *10211, 10259, 13320*, type.

Mr. Cooke's notes on the habitat of *Secotium longipes* are as follows:

" In the transition zone where it merges with the Canadian zone

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FIGS. 1–17. Drawings by Mrs. D. P. Rogers. 1, *Secotium longipes*, nat. size; 2, spores of *S. longipes*, × 1000; 3, *Sedecula pulvinata*, nat. size; 4, vertical median section of *S. pulvinata*, nat. size; 5, spores of *S. pulvinata*, × 500; 6, *Secotium polytrichoides*, × 1.5; 7, spores of *S. polytrichoides*, × 1000; 8, pileus of *S. polytrichoides* with one side cut away showing the lamellation of the gleba, × 4; 9, *Secotium nubigenum*, nat. size; 10, vertical median section of *S. nubigenum*, nat. size; 11, spores of *S. nubigenum*, × 1000; 12, vertical median section of *S. eburneum*, nat. size; 13, spores of *S. eburneum*, × 1000; 14, vertical median section of *Dendrogaster elasmomycetoides*, nat. size; 15, spores of *D. elasmomycetoides*, × 1000; 16, vertical median section of *Secotium pingue*, nat. size; 17, spores of *S. pingue*, × 1000.

on the south slope of Mt. Shasta is a large Veratrum meadow known as Wagon Camp. The west end of Wagon Camp is formed through the origin of a rather large spring. This spring flows to the junction with the west fork of Panther Creek until mid summer when it dries back toward its source. The area from which these specimens were taken includes a small flat marshy 'alluvial bottoms' type of location along the permanent portion of this creek. This bottoms section is about 5 ft. wide at the point where the specimens were collected. The forest is mainly *Abies magnifica* var. *shastensis* and *A. concolor*. *Ceanothus velutinus* and *Prunus emarginatus* form the understory at this point. Herbage along the creek includes species of *Mimulus, Epilobium, Salvia,* and various grasses. Fructifications of the fungus were scattered. At maturity the pileus droops to the ground making the older fruiting bodies rather inconspicuous."

15. SECOTIUM LUTESCENS Lloyd.

A study of the type material loaned by John A. Stevenson, Mycological Collections, Bureau of Plant Industry, USDA., revealed that this is not a *Secotium,* but rather an Agaric. It is most probably some species of *Galera.*

The spores are ellipsoid to ovoid, germ pore at distal end, attached obliquely below, brown, 11.2–13.2 × 6.2–7.6 μ.

16. SECOTIUM NUBIGENUM Harkness.

Through certain "acts of God" in California the type of this species has evidently been destroyed, there being no specimen under that name in the Harkness collections at the California Academy of Science or at the Dudley Herbarium, Stanford University. The Harkness species is so distinct in spore size and other characters, however, that material collected on Mt. Shasta by Wm. B. Cooke (No. *10174*) was readily referred to it. The specimens were growing on rotten logs of *Abies magnifica* var. *shastensis,* July 1, 1938.

The formal description of *S. nubigenum* is as follows:

Fructifications gregarious or solitary, subglobose to turbinate, subpileate and umbonate, base more or less conical and covered

by a scanty, evanescent veil, 1.5–4 cm. broad, 2–4 cm. tall (FIGS. 9, 10); surface grayish straw-colored to darker, smooth; peridium thin, sometimes breaking away from the stipe below; gleba brown, with variable sized cavities; stipe stout, somewhat bulbose, tapering upward, percurrent above; a few ovoid cystidia present; spores ellipsoid to ovoid, brown, smooth, 6.5–8.2 × 4.9–5.4 μ (FIG. 11).

17. **Secotium pingue** sp. nov.

Fructificationes 5–6 cm. altae, 5 cm. crassae; pileo depresso-globoso, firmo, ad basim penitus excavato, superficie laevi, luteo-albida cum maculis brunneo-lutescentibus; stipite concolori, glabro, sursum attenuato, inferne ultra 2 cm. crasso, superne in columellam crassam percurrentem procurrenti, farcto; peridio superne circa 2 mm. crasso, inferne tenuissimo e stipite separabili; gleba fusco-brunnea, locellis parvis, e columella radiantibus; basidiis anguste clavatis, 2- et 4-sporigeris; sporis fusco-brunneis, ovoideo-ellipsoideis, verrucosis, 12.5–16.3 × 8–9.5 μ.

Fructifications 5–6 cm. tall, 5 cm. broad; cap depressed globose, base excavated ⅓ the way up the columella, firm (FIG. 16); surface smooth, buffy whitish with brownish-yellow spots in preservative; stipe concolorous smooth, tapering upward, over 2 cm. in diameter below, percurrent as a stout columella, stuffed; peridium about 2 mm. thick above, very thin below where it separates from the stipe; gleba Dresden brown in preservative; cavities small, radiating from the columella; basidia narrowly clavate, 2- and 4-spored; spores dark brown, ovoid-ellipsoid, verrucose, 12.5–16.3 × 8–9.5 μ (FIG. 17).

Under duff on *Abies,* grove south of Horse Camp, Mt. Shasta, California, July 25, 1939, *Wm. B. Cooke,* No. *13362,* type (in Zeller Herb.).

Under oil immersion the spores are distinctly verrucose, especially so at and near the distal end. In lactophenol-fuchsin-methol-blue the spores show a closely applied gelatinous sheath (utricle). Many spores have a very short papillate remains of the sterigma. Sought out by rodents.

18. **Secotium polytrichoides** sp. nov.

Fructificationes 3.5–11 cm. altae, tenuissimae; pileo 6–12 mm. alto, ad basim 3–4 mm. crasso, ellipsoideo vel conico, apice acuto, basi attenuata vel truncata, margine fibrillis albis longis decurrentibus fimbriato, superficie glabra, inferne subrimosa, cremea, siccitate obscuriore; stipite 1–2 mm. crasso, terete, aequo, tenaci, glabro, concolori; gleba fusco-brunnea, locellis

paucis, elongatis, plerumque e stipite radiantibus; sporis fusco-brunneis, laevibus, obovoideis, episporo crasso, 8.7–10 × 5.8–6.3 μ.

Fructifications 3.5–11 cm. tall, very slender (FIG. 6); pileus 6–12 mm. long, 3–4 mm. broad at the base, ellipsoid or conical, apex acute, base attenuate or truncate at maturity, margin fimbriate, mostly with long decurrent, whitish fibrils, surface smooth, somewhat rimose below, tan, drying darker; stem 3–9 cm. long below the pileus, 1–2 mm. in diameter, terete, equal, tough, smooth, concolorous; gleba dark-brown, cavities few, elongate, separated by thin anastomosing lamellar partitions (FIG. 8); spores dark-brown, smooth, obovoid with a thick epispore, 8.7–10 × 5.8–6.3 μ (FIG. 7).

Scatteringly gregarious, on moist ground among grass and rushes, elevation 8100 ft., Horse Camp, Mt. Shasta, Siskiyou county, California. July and August. Collected by *Wm. B. Cooke,* Nos. *7646* (in Univ. of Calif. Herb. No. *568640*), *8612, 8623, 8660, 10276 type, 13313.*

The small nodding caps on very slender wire-like stems remind one of the stalked fruiting capsules of the moss, *Polytrichum,* with calyptra closely hugging the capsule and stem; some of them are not much larger.

Sedecula gen. nov.

Fructificationes hypogeae, pulvinatae, coriaceae, sine basi sterili radicibusque; peridio crasso, superne coriaceo, inferne paene obsoleto dehiscentique; gleba atra, pulveracenti, cum venis crassis albis, a peridio in centrum vergentibus, ceterum ut *Sclerodermatis;* sporis brunneis, ellipsoideis vel irregularibus, laevibus.

Fructifications hypogeous, pulvinate, leathery, without sterile base or radicle; peridium thick, leathery above, almost obsolete below, dehiscing below; gleba black with broad whitish veins extending inward from the peridium, becoming powdery and otherwise as in *Scleroderma;* spores brown, ellipsoid to irregular, smooth.

Type species, *Sedecula pulvinata.*

This odd genus because of its heavy peridium and glebal characters is referred to the *Sclerodermataceae.* Young specimens should be studied to learn the sequence of glebal development. From the 3 mature specimens at hand development of the gleba would appear to be centripetal.

19. **Sedecula pulvinata** sp. nov.

Fructificationes pulvinatae, 2–6 cm. crassae, 1–3 cm. altae, superficie glabra vel granulosa, alba vel griseola; peridio tenaci, coriaceo, superne 2–3 mm. crasso, inferne tenui subevanescentique, peridii crassi marginibus leviter involutis, parenchymaticis, albidis, cellulis magnis compositis; glebae parietibus magnis in centrum a peridiis vergentibus; gleba atra, pulverascenti; basidiis clavatis, 2-sporigeris, sterigmatibus brevibus; sporis obscure brunneis, ovoideis vel subellipsoideis vel irregularibus, breve pedicellatis, 23–26 × 13–16.2 μ.

Fructifications pulvinate, 2–6 cm. broad, 1–3 cm. high, surface smooth to granular, white to grayish (FIGS. 3, 4); peridium tough, leathery, 2–3 mm. thick above, thin and almost evanescent below, margin of thicker peridium usually somewhat rolled under so as sometimes to elevate the basal or under side having the thinner peridial cover, composed of whitish parenchyma of large cells with heavy gelatinized walls; larger partitions of the gleba (plates) extend centripetally to unequal depths toward the base and center from the peridium with which they have unbroken connection and the same structure; gleba black except for the whitish partitions (plates), becoming powdery at maturity; basidia narrrow-clavate, 2-spored; sterigmata about as long as the spores, slender; spores dark-brown (black in mass), ovoid to somewhat ellipsoid or irregular, usually very short-pedicellate, 23–26 × 13–16.2 μ (FIG. 5).

Under Shasta Fir duff, elevation 7000 feet on Mt. Shasta, Siskiyou county, California, *W. B. Cooke,* No. *10,307,* type, Sept. 16, 1938. (In Cooke Herb. and in Zeller Herb. No. *8497.*)

20. ABSTOMA RETICULATUM Cunningham.

Under Cypress, Point Lobos near Pacific Grove, Monterey county, Calif. Two collections were taken by Dr. Gertrude S. Burlingham, Jan. 6 and Mar. 26, 1937.

It is of interest to give this first report of a species of *Abstoma* from America, the genus having been reported before from Australia and New Zealand only. Dr. G. H. Cunningham, author of the genus, says in verification of our identification of one of the California collections, "I should refer it with confidence to *A. reticulatum.*"

21. CALVATIA TATRENSIS Hollos.

Hat Point about 23 miles above Imnaha, Wallowa county, Oregon; collected by Dr. D. P. Rogers, July 27, 1939.

This is the first report of this fungus from America but it answers the description by Hollos perfectly, and occurs at altitudes in Oregon mountains similar to those reported by Hollos in central Europe.

22. **Endogone rosea** sp. nov.

Fructificationes spheroideae vel pyriformibus, basi sterili inferne attenuata, cum funiculo tenui, 3–9 mm. crassae; superficie levi, alba, griseolescenti; intus zygosporiferae roseae, firmae; zygosporis in parte superiore dissipatis e conjugatione hypharum magnarum duarum ortis, 110–125 × 60–90 μ.

Fructifications spheroid to pyriform, attached below by a sterile base, 3–9 mm. in diam.; surface smooth, white, becoming grayish; zygosporiferous interior a rosy-color, firm; zygospores arising scatteringly throughout the upper portion, from the conjugation of two large swollen hyphae from which cells are cut by subtending septa, 110–125 × 60–90 μ.

About one inch under forest duff. Collected by *H. M. Gilkey*, foot of Alsea Mt., Benton Co., Oregon.

THE TAXONOMY OF ZENKER'S LEPTOSTROMA CAMELLIAE

William W. Diehl

(with 1 figure)

Over a century ago Zenker[1] published a short account of a newly discovered fungus found upon leaves of *Camellia japonica.* He did not explain where the fungus and its host were found; but it is a natural assumption that it was in Germany, either at Jena where he lived or nearby, since by that time *Camellia* culture had ceased to be a novelty. It is, moreover, most unlikely that the specimen was found distant from that locality or the record would be explicit. Although the species would seem to be morphologically distinctive and it was duly recorded in the Sylloge Fungorum of Saccardo, there appears to have been no other record of it despite the fact that it might have been expected to appear again upon Camellias.

AN AMERICAN RECORD

That Zenker's description and illustrations (fig. *A*) are trustworthy is, however, borne out by the evidence of some specimens sent from the A. & M. College of Mississippi in November 1931 and also from Meridian, Miss. (fig. *B*), in December 1931.[2] The writer identified these specimens and was naturally impressed by the startling reappearance of Zenker's species after the lapse of nearly a century. It seemed, therefore, worth while to attempt an explanation for this reappearance and to obtain, if possible, more complete information on the life history of the fungus since there was a possibility that it might be a pathogen newly arrived in

[1] Zenker, J. C. Ueber einen neuen Pilz auf *Camellia japonica.* Flora 17[1]: 211–213. *pl. III, fig. 1–7.* 1834.

[2] These specimens were collected by Clay Lyle and M. L. Grimes, respectively; Mr. Lyle's specimen was most kindly made available by Miss V. K. Charles.

America. The fungus was, consequently, given more thorough study than would be accorded the usual problem in specific identification, including cultivating it upon artificial media and searching for it in the field.

APPEARANCE OF THE SPECIMENS

The specimens were small, black, button-like pads about 2 mm. in diameter, firmly attached or agglutinated to the surface of the green *Camellia* leaf, with every indication of having grown there either out of the leaf or from some insect upon it. There was no discoloration of the leaves and a study of stained sections of the leaf tissues with the attached fungous pads made free-hand and of imbedded material cut with the microtome,[3] failed to disclose any hyphae within the leaf tissues. There was likewise no sign of insect remains upon which the fungus might have subsisted.

CULTURES ON ARTIFICIAL MEDIA

Pure cultures were easily obtained upon cornmeal agar, and transfers to several of the common agar media grew readily to form a gray cottony growth that in tubes with waxed stoppers did not form any fructifications during the entire year they were kept under observation. The only diagnostic feature noted was clamp-connection hyphae which suggested that the fungus was a Basidiomycete.

FIELD OBSERVATIONS

Late in December 1932 on a motor trip from Washington, D. C., to South Florida, considerable time was spent at likely places on the way in looking for this fungus upon the leaves of *Camellia* bushes. On the return, however, at Savannah, Ga. (Jan. 6, 1933) a stop was made at a commercial nursery to examine a large collection of *Camellia* plants where the answer to the problem appeared made to order:

Numerous large bushes were growing luxuriantly in the protection of a lath-shade. The lower leaves on many bushes were

[3] The writer is indebted to Dr. R. M. Whelden, of Cambridge, Mass., for the preparation of these microtome sections.

liberally speckled, chiefly on the under surfaces, with black, button-shaped fungous pads similar to those on the specimens from Mississippi. In the Georgia material, the "buttons" were, however, of smaller diameter—possibly a different but related species! It was noted that the "buttons" were especially common on leaves near the ground becoming scarcer above two feet high. As in the Mississippi specimens there was here no discoloration of the leaves where these "buttons" were attached. Leaves were searched for evidence of scale or other possible insect host upon which the fungus might have grown, but the foliage was exceptionally clean and free from any suggestive insect host. It was reasoned that, since most of these black fungous "buttons" were on the lower sides of the leaves, more rarely on top, chiefly near the ground, they might have been projected from some point of origin below. On the ground in the deep shade of these evergreen bushes was a checker-board pattern of wood slivers, decaying fragments of the boxes which had originally contained the rooted *Camellia* cuttings now become large bushes. As the roots had grown through the rotted bottoms of these boxes into the soil below, all the boxes had disintegrated except for the upper parts of the sides now left as slivers. These decayed remnants of the boxes were liberally studded with the funnel-shaped fruits of a bird's-nest fungus, which was later identified as *Cyathus pallidus* Berk. & Curt.; and the eggs or peridioles of this fungus were identical with the black, button-like pads upon the foliage above. With this comparable case in evidence it is a relatively simple matter to identify the glutinous, black, button-like fungous pads on the *Camellia* leaves from Mississippi (FIG. *B*) as peridioles belonging to some species of *Cyathus*.

THE SYNONYMY OF LEPTOSTROMA CAMELLIAE

Zenker's fungus might, of course, be referred to other genera were it not for the presence of remnants of a well developed funiculus actually indicated by the apical papilla in Zenker's illustrations here reproduced (FIG. *A:* 3–6) as well as shown in the illustration of the section of a Mississippi specimen where it is under the attached periodiole (FIG. *C*). In certain of the Mis-

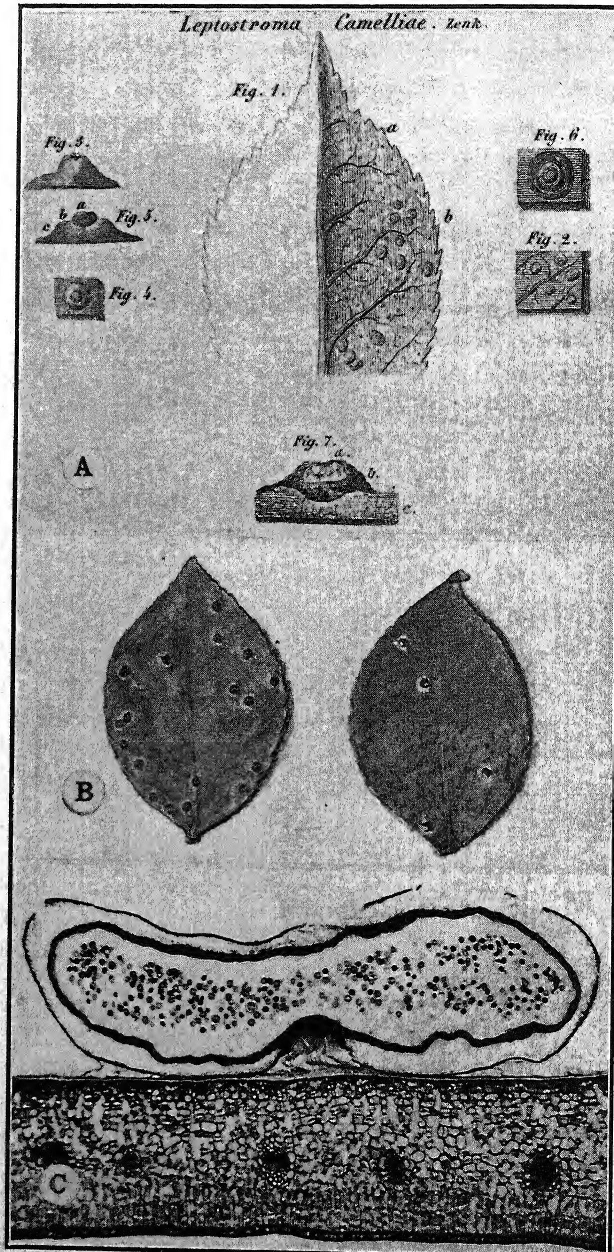
Leptostroma Camelliae. Zenk.
Fig. 1.
a
b
Fig. 3.
Fig. 5.
a
b
c
Fig. 4.
Fig. 6.
Fig. 2.
Fig. 7.
a.
b.
c.
A
B
C

FIG. 1.

sissippi material the funiculus was coiled up, appearing as an apical papilla oriented in reverse with relation to the *Camellia* leaf as in Zenker's illustration. The spores are similar in size and shape to those of *Cyathus stercoreus* (Schw.) De-Toni, which was not known to occur in Europe in 1834, although it is now recognized as practically cosmopolitan. It is ubiquitous on dung and manured substrata and is a species most likely to have been growing upon the ground or upon wooden receptacles in which Zenker's *Camellia* bushes were grown. The extremely glutinous surface of wetted peridioles of this species causes them to adhere closely to any substratum.

No attempt is made at this time to explain how peridioles could be projected through the air to leaves above the sporocarps of this species, but G. W. Martin's account[4] of the dissemination by spattering raindrops of peridioles in the related *Crucibulum vulgare* is very suggestive.

CONCLUSION

Leptostroma Camelliae Zenker, hitherto unknown except for the original description of a fungus on *Camellia* leaves, is here identified as peridioles of *Cyathus stercoreus* (Schw.) De-Toni. The peridioles of this species as well as of the related *C. pallidus* Berk. & Curt. when projected onto leaves and other objects adhere so closely by means of a glutinous coating that they appear to have grown in that position.

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[4] Martin, G. W. Basidia and spores of the Nidulariaceae. Mycologia **19**: 234–247. 1927.

FIG. 1, *A*, reproduction of Zenker's illustration of *Leptostroma Camelliae* from Flora **17**: pl. III. 1834; *B*, photograph from watercolor drawing of two *Camellia* leaves from Meridian, Miss., 1931, showing attached peridioles of *Cyathus stercoreus* (× 0.6); *C*, photomicrograph of vertical section through peridiole of *Cyathus stercoreus* attached to *Camellia* leaf (× 400). (Photographs by M. L. F. Foubert.)

OBSERVATIONS ON CERTAIN SPECIES OF APHANOMYCES [1]

VICTOR M. CUTTER, JR.

(WITH 15 FIGURES)

While searching for Phycomycetous fungi in the submerged exuviae of aquatic insects during the summer of 1940, several interesting species of the genus *Aphanomyces* were encountered. The identity of two of these proved puzzling and a search of the existing literature on the subject indicated that neither of them corresponded completely with any published description. Since these forms appeared to be fairly common in the vicinity of Ann Arbor, Michigan, further study of them seemed desirable. At the same time, Dr. F. K. Sparrow, Jr., kindly made available preserved material of a number of other species of *Aphanomyces,* collected from time to time by him. A study of these forms revealed a great deal of variation among them. Since the preserved material was in excellent condition, it appeared worthwhile to undertake a comparative morphological study of as many of the aquatic species of this genus as possible in the hope of clarifying to some extent certain obscure aspects of these fungi, in particular, specific limits.

The genus *Aphanomyces* was erected by de Bary in 1860 and since that time approximately 20 more or less distinct species have been described by various workers from many parts of the world. It is interesting to note that the species are for the most part distributed in the temperate zones, and few records are extant from any tropical countries. Species have been described from many types of substrate, including other aquatic fungi, algae, the exuviae of aquatic insects, insect cadavers in water, aquatic animals, and higher plants.

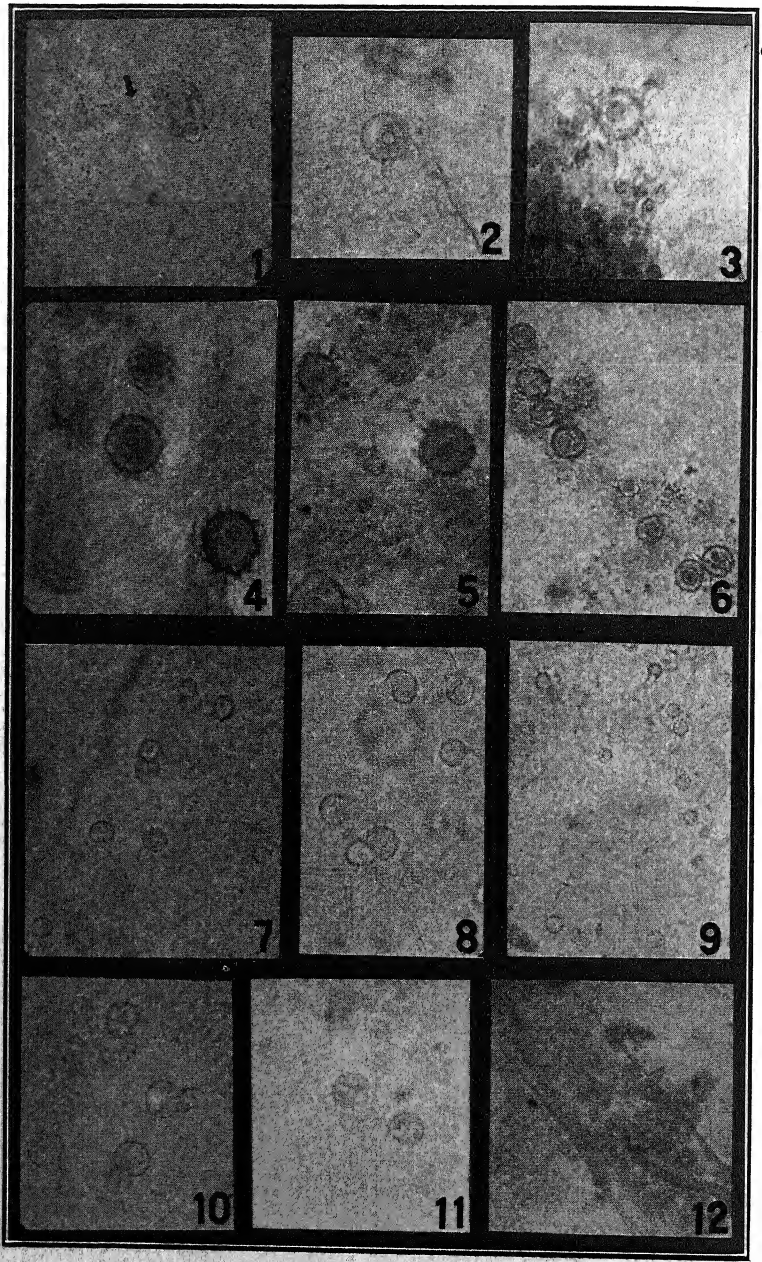
The members of this genus fall into two main categories de-

[1] Contribution from the Department of Botany, Univ. of Michigan No. 770.

pendent on the characteristics of the oögonial wall, which may be smooth or variously ornamented. Species with smooth oögonial walls, of which *A. laevis* de Bary may be considered typical, are for the most part saprophytes on various organic substrates or parasites of aquatic animals and higher plants. Drechsler (5) has described a series of smooth walled congeneric forms occurring in nature as parasites of various vegetables, all of which may be cultivated as saprophytes on artificial media, and hence are probably only facultative parasites. *A. laevis* de Bary, apparently the most commonly collected species of the genus, has been reported from a wide variety of substrates, usually from aquatic habitats. Coker (2), Couch (3), and Petersen (9) have pointed out that it is in all probability a very variable species. Bartsch and Wolf (1) have described a smooth walled species *A. acinetophagus* which attacks the protozoan *Acineta flava*. *A. helicoides* Minden, the remaining smooth walled species, has been reported on ant eggs in water. The other species of the genus are all characterized by the presence on the oögonial walls of roughenings, tuberculations, or spines. To judge from the infrequent reports in the literature these species are of sporadic occurrence, and as far as is now known are strictly aquatic. Couch (3) has pointed out that most of them upon occasion show parasitic tendencies. The only thoroughly investigated form in this series, *A. exoparasiticus* Coker & Couch, has been shown (3) to act under various conditions as a parasite, a hemi-parasite, or a true saprophyte.

Little is known concerning the degree of intergradation occurring among the several closely related species with ornamented oögonial walls. This is probably due in part to the difficulties involved in securing sufficient material for a comparative study, and in part to certain obvious discrepancies in the older literature which obscure our conceptions of specific limits. The results of the present study indicate, however, that the thickness of the oöspore wall is remarkably consistent in a given species and furnishes a most important and reliable supplementary character for the separation of species. This will be discussed under the species concerned.

Materials for this investigation were obtained from numerous collections of insects, exuviae, and algae in the vicinity of Ann



FIGS. 1–12.

Arbor, Michigan, and in preserved material of similar type collected by Sparrow from Denmark, England, Ithaca, N. Y., Cold Spring Harbor, N. Y., and Arlington, Mass. For the most part no attempts were made to grow these forms in pure culture, and all observations were made from material *in situ*. However, *A. laevis* and *A. helicoides* were both grown in water culture for a short period of time on the boiled cotyledons of Indian Hemp. With one or two exceptions, cultures of the forms so grown remained in the vegetative condition and did not produce sex organs.

SPECIES OBSERVED

APHANOMYCES HELICOIDES Minden. Krypt.-fl. Brand. **5**: 556. 1915. FIGS. 1, 2, 13 G–L.

The type material of this species was collected near Hamburg, Germany, on ant eggs in water. So far as is known, it has not since been reported. Coker (2) points out that it may probably only represent an extreme variation of *A. laevis*, in which the oögonial wall exhibits a brownish coloration and the antheridial branches show a strong tendency to involve the oögonium and the oögonial stalk in an helical coil. He mentions in this connection a form of *A. laevis* collected at Chapel Hill, N. C., in which the same pronounced coiling on the part of the antheridial branches was observed. However, Minden's fungus is further characterized by the tendency of the oögonia to occur in dense groups, and by the presence of certain antheridial tangles which form indiscriminately on the mycelia even where oögonia are lacking. Couch (3) describes a form of *A. laevis* from Wisconsin which in almost all respects fits Minden's description. To judge from Couch's remarks, however, the helical nature of the antheridial branches in his form is not so pronounced as in *A. helicoides*.

FIG. 1. *A. helicoides*. Showing helical nature of branches. Arrow indicates oögonial stalk. × 400. FIG. 2. *A. helicoides*. Oögonia with thin walled oöspore. × 400. FIG. 3. *A. Sparrowi*. On *Nitella* sp. Oögonia growing among host chloroplasts. Note bifurcated spines. × 600. FIGS. 4–5. *A. phycophilus*. On *Spirogyra* sp. Oögonia at lower right of fig. 4 growing inside host cell. × 400. FIG. 6. *A. scaber*. In filament of *Spirogyra* sp. × 400. FIGS. 7–11. *A. amphigynus*. On exuvia of a mayfly. × 600. Fig. 9 ×280. FIG. 12. *A. parasiticus*. On hyphal thread of *Achlya* sp.

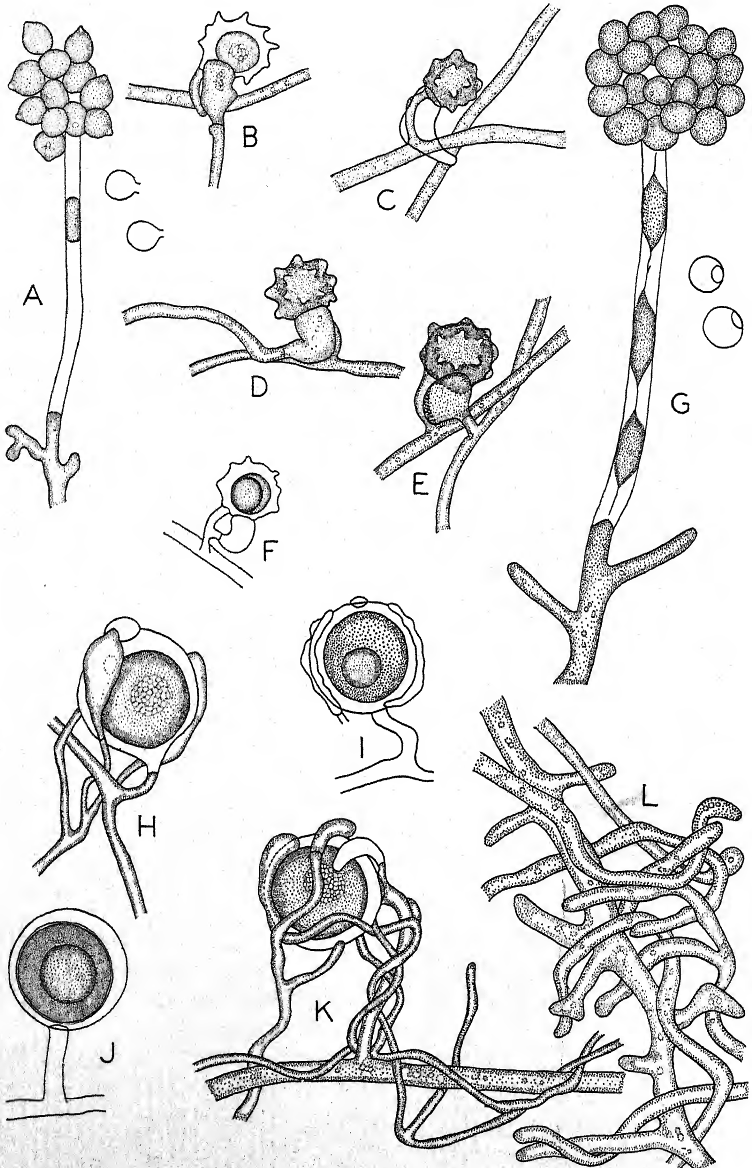


FIG. 13.

In the vicinity of Ann Arbor, Michigan, a fungus is commonly found in the submerged exuviae of certain aquatic insects, particularly those of the larger *Ephemerida* and *Odonata,* which in all respects corresponds closely with Minden's description of *A. helicoides.* In certain localities almost every one of these exuviae examined was found to harbor it. The oögonia are produced abundantly in characteristically scattered groups, as many as 30 or 40 sometimes occurring together in one group. This grouping of the oogonia suggests the possibility of a heterothallic condition, although further investigation will be required to verify this. The oögonial walls are at all times smooth and unpitted, but in age may because of the persistent nature of the collapsed antheridia appear somewhat roughened (FIG. 13, *I*). At many points on the vegetative mycelium clusters of short intertwined mycelial branches arise to form characteristic knots (FIG. 13, *L*), which in the author's opinion appear to correspond to the antheridial tangles mentioned by Minden (8). The function of these mycelial knots is uncertain, but they may possibly arise as the result of an incomplete sexual stimulus, or in response to an increased nutrient concentration in certain portions of the substrate. They are distinguished with difficulty from the functional antheridial branches but may be somewhat thicker and more convoluted. The number of antheridia associated with a single oögonium is very variable in this form but averages 3–5. The antheridial branches are commonly long and diclinous, and show a pronounced coiling or snake-like twisting around the oögonial stalk. This characteristic is maintained in material grown on hempseed in water culture, although the oögonia are scarce under these circumstances. The sporangia in this species are in no way distinguishable from those of *A. laevis,* but the vegetative mycelium from which they arise commonly displays a light brown color, which is not, however,

FIG. 13. All drawings made with the aid of a camera lucida at an approximate magnification of 600 diameters. *A, A. amphigynus,* zoösporangium showing strongly papillate cystospores and empty cysts; *B–F, A. amphigynus,* types of oögonia and antheridia; *G, A. helicoides,* zoösporangium with cystospores and empty cysts; *H–K, A. helicoides,* types of oögonia and antheridia; *I* shows a mature oögonium with walls apparently roughened due to persistent antheridia (note thin wall of mature oöspore in *J*); *L, A. helicoides,* characteristic hyphal knot that may correspond to the antheridial tangles referred to in text.

retained in material grown on hempseed. Our material is further characterized by the extremely thin wall of the mature oöspore (FIG. 13, *J*), which in all of the material examined never attained a thickness of more than 1.5 μ. Minden (8) unfortunately does not state the thickness of the oöspore wall in his species, but since our material corresponds so perfectly with his description in all other respects we feel justified in referring it to *A. helicoides.* The extremely thin nature of the oöspore wall serves to separate this material from *A. laevis,* which has been described by several investigators as having a thickened oöspore wall up to 3 μ in thickness, and from the form of *A. laevis* described by Couch (3) which has an oöspore wall that is conspicuously thickened. In apparently typical material of *A. laevis* studied during the course of this investigation the oöspore wall was commonly 2.5–3 μ thick. Although Coker (2) has pointed out that the limits of *A. laevis* may be extended to embrace *A. helicoides,* it appears on the basis of the characters mentioned above to be specifically distinct. The following description was compiled from the Michigan material.

Hyphae hyaline or brownish, 4–7.5 μ in diam., abundantly branched, sometimes forming characteristic knots, ramifying through and over the substrate; sporangia long, not to be distinguished from the vegetative mycelium, terminal or lateral; zoöspores in a single file in the sporangium, spindle-shaped with sharp tapering ends, 5×10 μ, becoming globose upon emergence and encysting at the mouth of sporangium, cystospores 8–11 μ in diam., free swimming zoöspores bean-shaped, laterally biflagellate, 6×9 μ; oögonia on short, lateral branches, frequently in dense clusters on the substrate, 21–35 μ in diam. with smooth, brownish, unpitted walls; oöspores single, large, oil globule eccentric at maturity, oöspore wall very thin, rarely reaching 1.5 μ in thickness; antheridia 1–5 μ, present on all oögonia, androgynous or diclinous, wrapping closely around the oögonium and sometimes almost covering it, persistent after fertilization, then appearing as roughenings on the oögonial walls; antheridial branches slender, frequently in helical coils around the oögonial stalks.

Saprophytic on the exuviae of aquatic insects. On hempseed forming a limited, scarcely branched, white mycelium 2–4 mm. in extent.

APHANOMYCES LAEVIS de Bary forma.

A form, which differed from typical *A. laevis* in the smaller dimensions of its oögonia and oöspores and in its more slender vegetative hyphae, was collected once on the nymph of a species of *Odonata*. It was particularly noteworthy because of the extremely short oögonial stalks and the peculiar diverticulate nature of the antheridial cluster. The branches that formed these clusters were very short and swollen, and arose close to the oögonia but on different branches. No instance could be found where the antheridia were definitely androgynous. Since this form was not obtained in culture, it does not seem worthy of specific designation without further study.

Hyphae hyaline, 3–6.5 μ in diam., abundantly branched; sporangia long, same diameter as vegetative hyphae; zoöspores as in the species, cystospores 7–9 μ in diam.; oögonia spherical with hyaline, unpitted, thin walls, on very short lateral branches, 15–21 μ in diam.; oöspores single, hyaline, 12–18 μ in diam. with eccentric oil globule, wall up to 2 μ thick; antheridia diclinous, much lobed and convoluted, 3–5 μ on most oögonia, the antheridial branches very short, forming a characteristic cluster around the oögonium, persistent after fertilization.

Saprophytic on the nymph of a species of Odonata, Whitmore Lake, Washtenaw County, Mich., June 18, 1940.

Aphanomyces amphigynus sp. nov.

This species was encountered quite frequently in the larval skins of various aquatic insects around Ann Arbor, Michigan. It was also frequent in preserved exuviae collected in 1933 in Sealand, Denmark, by Dr. F. K. Sparrow, Jr. A fungus collected on grass culms suspended in water at Slaterville Springs, N. Y., by Sparrow, and reported by him (12) as *A. exoparasiticus* Coker & Couch, also appears from an examination of slides to be referable to the present species.

In the American material the oögonia generally appeared after the exuviae had been kept in a culture jar in water in the laboratory for about ten days. In the collection on grass culms the oögonia were scarce. The mycelium of the fungus was quite limited in extent, rarely occupying more than a small portion of the larval skin.

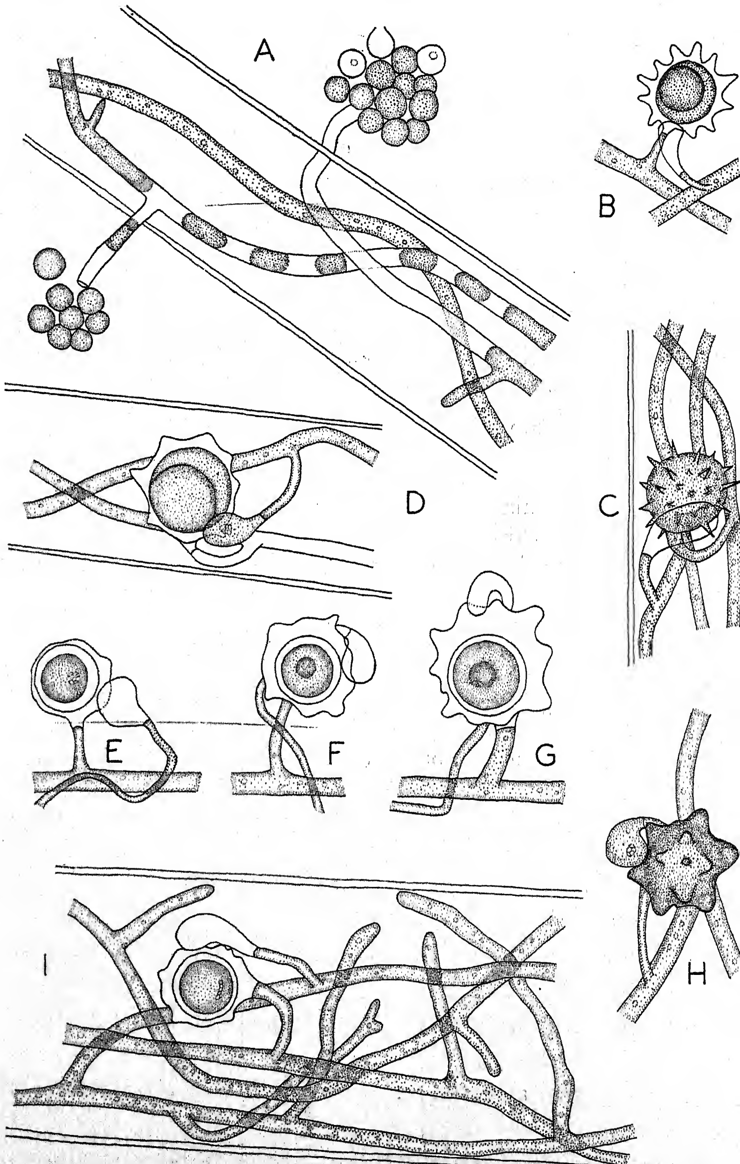


FIG. 14. All drawings made with the aid of a camera lucida, at an approximate magnification of 600 diameters. *A, A. parasiticus*, zoösporangia in hyphae of *Dictyuchus monosporus; B–B, A. parasiticus*, in hyphae of Achlya sp.; types of oögonia and antheridia (note large oöspore filling oögonium and prominent oil globule); *E–L, A. scaber*, on filaments of *Spirogyra* sp.; types of oögonia and antheridia (note subcentric nature of oil globule in *F* and *G*).

As may be seen from the accompanying description, *A. amphigynus* is evidently most closely related to *A. parasiticus* Coker, but differs in several very important respects. *A. parasiticus* has been reported only as an obligate parasite of certain other Saprolegniaceous fungi by Coker (2) and by Couch (3) and all efforts to culture it as a saprophyte have been unsuccessful. The present species on the other hand is obviously saprophytic. Well defined morphological differences are also apparent. The non-sexual stage of *A. amphigynus* may be distinguished from that of *A. parasiticus* by the strongly papillate nature of the cystospores. This character is pronounced not only at the time of emergence of the free swimming, laterally biflagellate zoöspores, but also throughout their period of encystment. The hyphal measurements are somewhat smaller than those of *A. parasiticus.* Further, Coker (2) has described the oögonial walls of his fungus as being warted to strongly spiny, and all the authentic material of *A. parasiticus* that has been examined by the author has had walls of the strongly spiny type. Sparrow (11) in discussing a fungus collected by him at Cold Spring Harbor, N. Y., on a species of *Achlya,* and designated as *A. parasiticus,* states that the dark-colored oögonial wall bore sharp, gradually attenuated spines 5–8 μ in length. His illustrations correspond well with those of Coker (2). In the present fungus the oögonial wall is characteristically more tuberculate than spiny, and the tubercles are but rarely sharp-pointed. The nature of the mature oöspore also appears to afford a reliable basis on which to distinguish these two species. In *A. parasiticus* the oöspore has been described as 12–21 μ in diameter, filling the oögonium completely at maturity. This description is verified in our material of *A. parasiticus.* In *A. amphigynus,* on the other hand, the oöspore is only 9–13 μ in diameter and in no instance does it even approximately fill the oögonium. Further, the antheridia of our species are somewhat larger in relation to the size of the oögonia than the antheridia figured by Coker (2) for *A. parasiticus.* Indeed, in many cases the single basal antheridium is larger than the oögonium (FIGS. 8, 10), and at times a single antheridium appears to fertilize two oögonia. Finally, measurements compiled from a large amount of Danish and American

material show our fungus to be somewhat smaller than *A. parasiticus*. For these reasons, it appears worthy of specific designation. The name proposed refers to the peculiar nature of the antheridia which frequently give the appearance of being penetrated by the oögonial stalk.

Hyphae hyaline, 2.5–4 μ in diam., sparingly branched, restricted, running over the surface of and through the substrate; sporangia short, of same diameter as the vegetative hyphae, terminal; zoöspores oblong with blunt rounded ends, formed in a single row in the sporangium, upon emergence becoming globose and encysting, cystospores 8–12 in number, 5–7 μ in diam. with a prominent papilla, free swimming zoöspores reniform, laterally biflagellate, 3 × 6 μ; oögonia 12–16 μ in diam. exclusive of the spines, borne on short circinate stalks, the oögonial wall hyaline, bearing scattered spines or blunt tubercles which may reach 2.5 μ in length; oöspores single, eccentric, not filling the oögonium, 9–13 μ in diam.; antheridia diclinous, single, large, bulbous, broad clavate, or irregularly oval, 9 × 14 μ, always applied basally and persistent after fertilization, at times appearing amphigynous to the oögonial stalk.

Hyphae hyalinae 2.5–4 μ crassae, parce ramosae, terminatae, percurrentes et summa substratum; sporangia brevia, terminalia, 2.5–4 μ diam.; zoosporae oblongae cum obtusis rotundis extremis, formati in una serie in sporangia, cum emergunt globosae encystantes, cystis 8–12 num., 5–7 μ diam. cum papilla prominente, zoosporae natantes reniformae, lateraliter biflagellatae 3 × 6 μ; oogonia 12–16 μ diam., sine spinis, prolata brevibus circinnatus stirpibus, murus oogoniarum hyalinus, ferens paucas acutas spinas vel obtusis processus usque 2.5 μ long.; oosporae singulae, eccentricae, non complentes oogonia, 9–13 μ diam.; antheridia declinus, solitaria, magna, tumefacta, lata clavata vel irregulariter ovata, 9 × 14 μ, semper applicata funditus et constantia post evacuaverunt, aliquando verisimilis amphigynia stirpi oogoniae.

Saprophytic on exuviae of aquatic insects. Type locality: Esröm Sö, Sealand, Denmark. Coll. F. K. Sparrow, Jr., 1933. Also in North America.

APHANOMYCES PARASITICUS Coker. The Saprolegniaceae; Chapel Hill, 165–167. *Pl. 57*. 1923.

Material of this species has been examined in collections made at Bartlett Pond, Arlington, Mass., 1928 and at Barton Mills, Suffolk, England, 1932 by Sparrow. The English fungus was

parasitizing *Dictyuchus monosporus* Lietgeb, whereas the American material occurred on an unidentified species of *Achlya*. All of the oögonia observed were of the sharp spiny type mentioned by Coker (2), and ranged in color from hyaline to light brown. Sparrow (**10**) has referred to the dark colored oögonial wall seen in fresh material of the Arlington collection, but this character was not apparent in the preserved material. However, it is reasonable to suppose that the color may have faded in the glycerin mounts. Beyond emphasizing the basal application of the antheridia and the fact that the oöspore almost completely fills the oögonium at maturity, nothing of importance can be added to Coker's original description.

Aphanomyces Sparrowii sp. nov.

This fungus was studied by Sparrow (**10**) in 1930 and reported as *A. phycophilus*. Later he revised his opinion (Sparrow, **12**) and pointed out that it was too small and delicate a form to be referable to that species. *A phycophilus* has oögonia which measure 40–50 μ in diameter, whereas those of the present fungus do not exceed 25 μ in diameter. The ornamentation of the oögonial walls of this species which bear very conspicuous sharp pointed spines is quite distinct from the prominent blunt tubercles typical of *A. phycophilus*. The spines in *A. Sparrowii* often exceed the diameter of the oögonium and are frequently bifurcated (FIG. 3). Further study has shown that it is not identical with any previously described form. It is easily separated from *A. exoparasiticus* Coker & Couch, the species with which it shows the closest affinity, by the smaller oögonia, oöspores with eccentric oil globules, and by the conspicuous golden coloration of oögonia and oöspores. Further differences are found in the disposition of the antheridial branches which do not twine around the oögonial stalks in the characteristic manner of *A. exoparasiticus,* and in the short, slender lateral sporangia which are quite different from those of the aforementioned species. From *A. parasiticus* and *A. amphigynus,* the other closely related forms, *A. Sparrowii* is distinguished by its much more prominent spines and the generally larger dimensions of the oögonia, by the golden color of the oögonial wall, and by

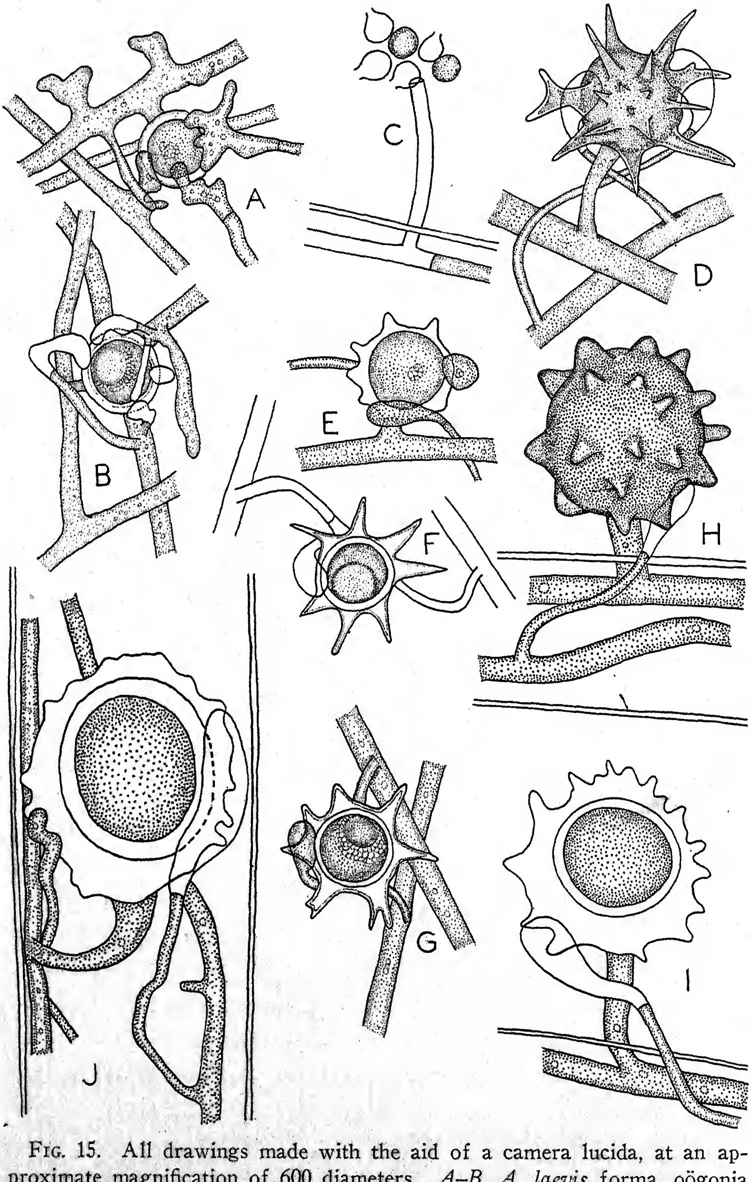


FIG. 15. All drawings made with the aid of a camera lucida, at an approximate magnification of 600 diameters. *A–B*, *A. laevis* forma, oögonia on the exuvia of a mayfly (note short and convoluted antheridia); *C*, *A. Sparrowii*, lateral zoösporangium with cystospores and empty cysts; *D–G*, *A. Sparrowii*, types of oögonia and antheridia growing on *Nitella* sp. (note very prominent spines and clavate antheridia; *H–J*, *A. phycophilus*, on *Spirogyra* sp.; oögonia and antheridia.

the thick walled oöspore. The lateral rather than basal application of the antheridia further distinguishes *A. Sparrowii* from these species. So far as is known this is the only species of *Aphanomyces* ever reported as parasitic on *Nitella*. Sparrow (**10**) has discussed the non-sexual stage of this fungus and nothing of importance can be added to his description except to emphasize, as he points out (**12**), that this is quite distinct from *A. phycophilus* de Bary. The species is named in honor of Dr. F. K. Sparrow, Jr., who collected it, and first recognized its unique character.

Hyphae hyaline, 6.5–14 μ in diam., scarcely branched, extending through the host tissue; sporangia short, lateral, thinner than the vegetative mycelium, 3.5–5 μ in diam., penetrating the host wall; zoöspore discharge not observed but presumably typical; cystospores 5–12 in number, 7–9 μ in diam.; oögonia borne on short lateral branches within the host cell, 16–25 μ in diam. exclusive of the spines; oögonial wall 1–1.5 μ thick, golden, unpitted, produced into numerous very prominent thick walled, frequently bifurcated, spines, 4.5–14 μ in length; oöspores single, golden, 14–22 μ in diam. with prominent eccentric oil globule, oöspore wall 1.5–3 μ thick; antheridia 1–3 to an oögonium, diclinous, bent clavate, borne on slender branches, persistent after fertilization.

Hyphae hyalinae, 6.5–14 μ crassae, parce ramosae, intramatricae; sporangia brevia, lateralia, tenior myceliis sterilibus, 3.5–5 μ crassa, perforentia murum hospitis; emissio zoosporarum non observata, sed manifeste propria; cystospora 5–12 num., 7–9 μ dia.; oogonia prolata brevibus lateralibus ramis, in cella hospitis, 16–25 μ dia. sine spinis; murus oogoniarum 1–1.5 μ crassus, flavens, sine foramenibus, eductis in multis prominentibus saepe bifurcatis spinis cum muris crassis, 4.5–14 μ long.; oosporae solitariae, flaventes, 14–22 μ dia. cum prominente eccentrico globulo, murus 1.5–3 μ crassus; antheridia 1–3, declinus, incurva clavata, super gracilis ramos, constantia post evacuaverunt.

Known from one collection in the internodal cell of a species of *Nitella* from Cold Spring Harbor, N. Y. Coll. F. K. Sparrow, Jr.

APHANOMYCES SCABER deBary, Jahrb. Wiss. Bot. p. 178. 1860. *Pl. 19.* FIGS. 6, 14 *E–I*.

This species appears to be predominantly saprophytic, but has been reported as parasitic on *Achlya* by Couch (**3**) and on *Spirogyra* by Humphrey (**7**). The present material, collected at Ithaca,

N. Y., by Sparrow and called *A. norvegicus* by him, occurred as a parasite on *Spirogyra*. Great numbers of oögonia were formed within the infected algal filaments with occasional ones borne on short stalks outside the host cells. The form and dimensions corresponded well with de Bary's original description. In contrast to the strain of *A. scaber* described from Chapel Hill, N. C., by Coker (2) and Couch (3) which lacked antheridia, the present material bore antheridia on at least ninety per cent of the oögonia. In some cases two antheridia were present on an oögonium. The ornamentations of the oögonial wall were extremely variable, ranging from mere irregularities to definite tuberculations. In its more extreme forms the oögonial walls approached the type of *A. phycophilus* de Bary, but it was immediately distinguished from that species by the much smaller dimensions of the oögonia (see table below), and the centric nature of the oil globule in the mature oöspore. The only other species with which it might be confused is *A. parasiticus*, from which it can be easily separated by the thick oöspore wall (1.5–3 μ) and the centric oil globule, as well as by the lateral application of the antheridia. In our material no zoösporangia were observed. Coker (2) states that the oöspores are eccentric, but in our material the oil globules were definitely centric in position. This difference cannot be given too much weight, however, since the material was not seen in the living state.

APHANOMYCES PHYCOPHILUS deBary, Jahrb. Wiss. Bot. pp. 179–182. *Pl. 20.* 1860. FIGS. 4, 5, 15 *H–J*.

Material of this species was studied from preserved material of *Spirogyra* sp. collected at Ithaca, N. Y., by Sparrow. The alga was heavily parasitized by two species of *Aphanomyces* which Sparrow (12) reported as *A. phycophilus* deBary and *A. norvegicus* Wille. Further study has indicated, however, that the species referred to *A. norvegicus* is quite typical of *A. scaber* deBary, and has been discussed under that species.

The material referred to *A. phycophilus* by Sparrow (12) appears in many respects to coincide with the original description of *A. norvegicus*. Wille (16) in his diagnosis of that species failed to give any measurements for his fungus, and separated it from *A. phycophilus* only on the basis of the brown coloration of the

oögonial walls, and on the fact that the fungus hyphae frequently encircle the algal filaments as well as transversing them. Both species were until recently known only as obligate parasites of the Conjugatae. Whiffen (15) has demonstrated, however, that *A. phycophilus* may be cultured as a saprophyte on agar. Couch (3) and Whiffen (15) have both shown that the oögonial wall may become brown at maturity, and that the hyphal threads often extend outside the host cells. Weatherwax (14) has described a form from Indiana with a hyaline oögonial wall that corresponds well with the original description of *A. phycophilus,* save in the somewhat smaller diameters of the oögonia, which average 26 μ in contrast to the 40–50 μ recorded by de Bary. In our material the oögonial walls range from hyaline to dark brown and the threads of the parasite occur both inside and outside the host filament. To judge from these accounts neither the color of the oögonial walls nor the orientation of the hyphal threads is a reliable criterion for the separation of *A. norvegicus* from *A. phycophilus,* since both characters are dependent in large measure on the age of the material and the degree to which infection of the host has occurred. Due to the inadequacy of Wille's original description of *A. norvegicus,* and to the obvious difficulties of separating it from *A. phycophilus,* which appears to be a rather variable species, we are led to the conclusion that there is little cause for retaining the former species in the literature. Gicklhorn (6) has described a species, *A. ovidestruens,* parasitic on the eggs of *Diaptomus,* which in its sexual stage might be confused with *A. phycophilus,* but the curious nature of the swollen basal holdfast cell on the vegetative mycelium, and the fact that it is only parasitic on living animals, indicates that it is distinct from the present species.

In the Ithaca material of *A. phycophilus,* the thickness of the oöspore wall was very noticeable, in extreme cases reaching 5.5 μ. A further peculiarity of this fungus was the apparent lack of any oil globule in the mature oöspore. De Bary (4) states that the contents of the oöspore are homogeneous, and neither Coker (2) nor Couch (3) mentions the presence of an oil globule. Whiffen (15) describes the contents of the mature oöspore as finely granular with oil droplets around the periphery. In this respect *A.*

Species	Oögonial Wall Ornamentation	Oögonial Diameter	Oögonial Coloration	Oöspore Diameter	Oöspore Coloration	Oöspore Wall Thickness	Nature of Oil Globule	No. of Antheridia per Oögonia	Antheridial Characters	Application of Antheridia
A. laevis	smooth	24–35 μ	hyaline	19–29 μ	hyaline	1.5–3 μ	eccentric	1–6 μ	diclinous androgynous	indiscriminate
A. laevis, forma	smooth	15–21 μ	hyaline	12–18 μ	hyaline	1.5–2 μ	eccentric	3–5 μ	diclinous on short branches	indiscriminate
A. helicoides	smooth	21–35 μ	brownish	16–27 μ	brown	0.5–1 μ	eccentric	1–5 μ	diclinous coiling around oögonial stalks	indiscriminate
A. Sparrowii	long, sometimes bifurcated spines 4.5–14 μ	16–25 μ	golden	14–22 μ	golden	1.5–3 μ	eccentric prominent	1–3 μ	diclinous bent-clavate	indiscriminate
A. parasiticus	sharp spines 2–4 μ	14–24 μ	hyaline to light brown	12–23 μ	hyaline	1 μ	eccentric prominent	1 μ	diclinous	basal
A. amphigynus	blunt spines or tubercles up to 2.5 μ	12–16 μ	hyaline	9–13 μ	hyaline	1 μ	eccentric or subcentric	1 μ	diclinous or androgynous very large 9 × 14 μ	basal
A. scaber	rough or with broad tubercles up to 3 μ	16–26 μ	hyaline to very light brown	12–20 μ	hyaline	2.5–4 μ	subcentric or centric small	0–2 μ	diclinous sometimes apandrous	indiscriminate
A. phycophilus	heavy sharp tubercles up to 9 μ	39–55 μ	hyaline to deep brown	35–43 μ	hyaline to brown	3–5.5 μ	no globule	1–3 μ	diclinous tuber-shaped	indiscriminate

[2] Since submitting this paper for publication a recent contribution by R. L. Smith (Studies on two strains of *Aphanomyces laevis* found occurring as wound parasites on crayfish), MYCOLOGIA **32**: 205–213, *fig. 1,* 1940, has come to my attention. This author's observations on the nature of the oöspore wall of *A. laevis* are not substantiated in the material discussed in the present paper.

phycophilus is unique among the species of the genus. The oögonia in our material were borne inside and outside the host in about equal numbers. Those born inside were frequently egg shaped due to compression by the walls of the host cells. The hyphal measurements of our fungus were somewhat smaller than those of de Bary's description, averaging 7–10 μ in diameter as compared to 10–15 μ in de Bary's form. No sporangia were encountered in this material which substantiates Couch's statement (**3**) regarding the rarity of this type of reproduction. Sparrow's description of the non-sexual reproduction of *A. phycophilus* (**11**) has been shown above to apply to a previously undescribed form.

DISCUSSION

In the study of water molds under natural conditions certain characteristics commonly used in the classification of these fungi, such as the color of various organs, generally prove upon investigation of a large number of specimens to be so inconsistent as to be of little value in making specific separations. This is particularly true of those characters which are in large part merely the physiologic manifestations of the basic nature of the substrate. A case in point is the use of the color of the oögonial wall of certain species of *Aphanomyces* (*A. phycophilus, A. norvegicus*) as a characteristic of specific rank. During the course of this study many instances have been found where in a single culture and indeed in a single host filament oögonia occurred which possessed walls ranging in color from hyaline to deepest brown, and this on oögonia of approximately the same stage of maturity. In view of the extensive color variation displayed by some of these species it appears that in this genus the use of color as a character for specific separation is a somewhat doubtful procedure.

The accompanying table indicates that a considerable amount of intergradation occurs among those species of the genus forming ornamented oögonia, with respect to the type of ornamentation displayed by the oögonial wall. The same holds true for the diameter of the oögonia. With the exception of *A. phycophilus,* the oögonial dimensions of the species studied overlap rather widely at their extremes. On the other hand the characteristics of the

oöspore such as the thickness of its wall and the position of the oil globule, and particularly the diameter of the oöspore in relation to the diameter of the oögonium, appear to be quite consistent among individuals of the same species. This is equally true in the smooth walled as well as in the spiny walled species that have been examined. From a large number of measurements and observations made on the above material we are led to the conclusion that the nature of the oöspore wall, and the position and appearance of the oil globule, present usually reliable characteristics for the separation of species.

The disposition, shape and manner of application of the antheridia are obviously important taxonomic features. In certain species such as *A. parasiticus* and *A. amphigynus* the antheridial characteristics are remarkably consistent. However, in certain other species, particularly *A. scaber* and *A. laevis,* the accounts of various workers (Coker, 2, Humphrey, 7) indicate that the type and nature of the antheridia are extremely variable; and indeed apandrous strains of these species apparently occur. Furthermore, it is frequently most difficult to determine with certainty the precise origin of the antheridial branches, and the exact application of the antheridia to the oögonia in cases where fertilization tubes are not developed. Hence we feel that, with the exceptions noted above, the antheridial characters cannot be considered too reliable in delimiting species. The nature and shape of the zoöspores and cystospores in the material that we have examined in the living state appear to be fairly constant for any one given species, and perhaps offer another reliable criterion for specific designation.

It is evident that a large number of isolates of these species must be collected from many sources and grown and studied in pure culture under identical conditions before our conception of the specific limits within the genus *Aphanomyces* becomes firmly established. The results of this study indicate that some of these species are extremely variable and the limits of this variation are not yet clearly defined.

SUMMARY

1. Eight species and one form of the genus *Aphanomyces,* from a number of collections, have been studied critically to determine

those characteristics which serve to demarcate most clearly the various species.

2. At the present time the oöspore characters appear to offer the most reliable criteria for the separation of the species studied.

3. *Aphanomyces helicoides* Minden is reported for the first time from America.

4. A species of *Aphanomyces, A. Sparrowii,* parasitic on *Nitella,* is described.

5. A species of *Aphanomyces* most closely related to *A. parasiticus,* but differing in its saprophytic nature and smaller dimensions, is described as *A. amphigynus*.

6. A form of *A. laevis* which differs from the species in the much smaller dimensions of oögonia and oöspores and in the diverticulate nature of the antheridial cluster is discussed.

In closing, the writer takes great pleasure in expressing his deep appreciation to Dr. F. K. Sparrow, Jr., who has given generously of both time and materials and under whose direction this study was carried out. He is also indebted to Mrs. Lucy Olson, who prepared the Latin diagnoses contained in this paper, and to the Department of Botany of the University of Michigan, who extended the privileges of their laboratories.

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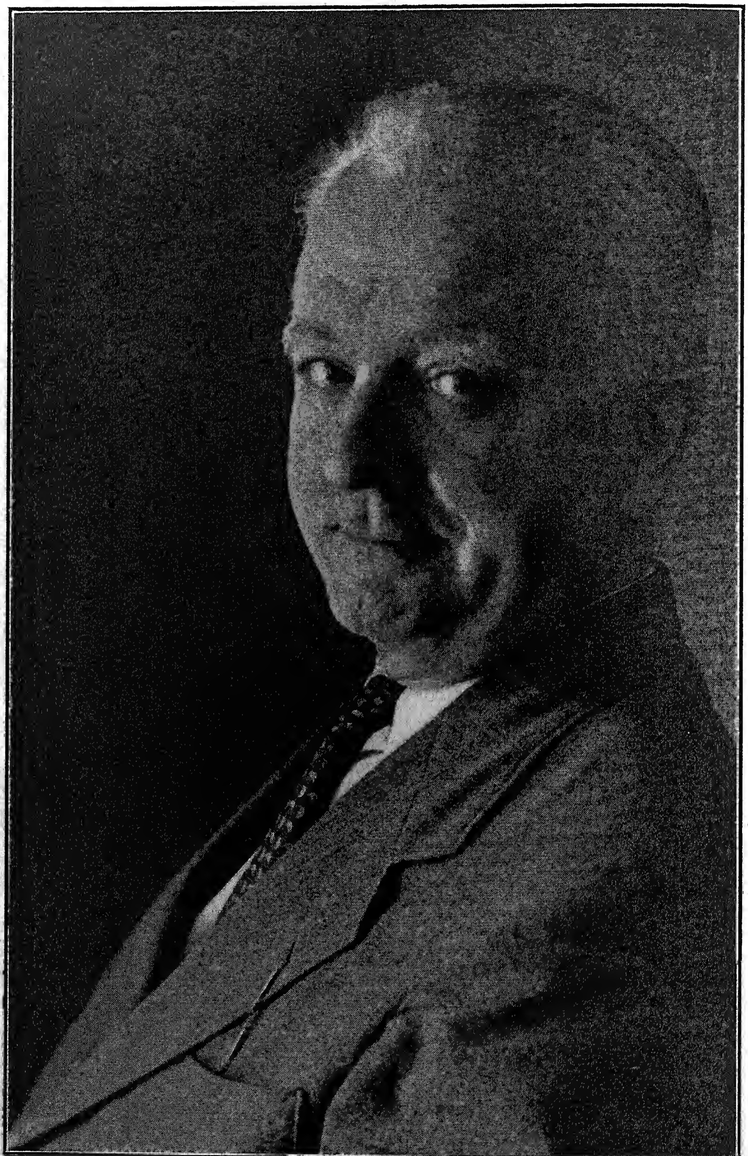

Louis Charles Christopher Krieger

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LOUIS CHARLES CHRISTOPHER KRIEGER, 1873–1940

JOHN A. STEVENSON

(WITH PORTRAIT)

A figure unique in the annals of American mycology passed from the scene of his earthly labors July 31, 1940. L. C. C. Krieger was the creator of the finest series of watercolor paintings of the fleshy fungi yet produced in America. The late C. G. Lloyd said of his work "Such perfection of illustration has never been reached by anyone else in this country and in Europe only by Boudier. There may never be another as competent as he." Not only do Krieger's plates approach perfection artistically, but they are technically correct as well to the most minute detail, a rare but much to be desired combination. In his zeal to perfect his mushroom paintings he acquired by long hours of patient study an astonishing knowledge of the larger American fungi, *Boletus* in particular, and of the pertinent literature.

Louis Charles Christopher Krieger was born in Baltimore, Maryland, February 11, 1873, the son of Henry and Katharine Lentner Krieger. His early education was obtained in the public and parochial (Lutheran) schools of his native city. His artistic capabilities were early apparent, and at the precocious age of 13 he was enrolled at the Maryland Institute School of Art and Design. Later his studies were continued at the Charcoal Club School of Fine Arts. His association with the latter institution continued through-

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out most of his life, and, in fact, such was his intimate connection with the Club, that his friends often referred to him as Louis "Charcoal Club" Krieger.

As a youth of 18 Krieger received his first appointment in the Department of Agriculture as an artist assistant, assigned to the Division of Microscopy. This was an interesting organization, the technical staff of which consisted of Dr. Thomas Taylor alone, who, since 1871 had been dabbling in all manner of activities involving the microscope and acting as his own artist.

At this time Dr. Taylor's chief hobby was the mushrooms, and his new staff member was put to work painting those found in and about the District of Columbia, and in copying certain of the plates from European works. Several of these early plates by Krieger appear in the Microscopist's report for 1893, and a number of others are in the files of the Mycological Collections of the Bureau of Plant Industry. During this period the young artist carefully saved the greater part of his annual stipend of $1000, being aided and abetted therein by his parents who permitted him to live at home in Baltimore without charge for board or lodging, though it is recorded that difficulties were encountered in getting the young commuter up and away, particularly on cold winter mornings.

The Hon. J. Sterling Morton, Secretary of Agriculture, dropped the entire division on June 30, 1895, for the reason that its activities overlapped those of other divisions. Another position would have been found for Krieger, since his talents were recognized, but he preferred to seize the opportunity for a long planned period of foreign study. Accordingly he spent the year 1895–96 at the Royal Bavarian Academy of Fine Arts in Munich where he industriously applied himself to the work in hand, not overlooking, however, the splendid opportunities then afforded in the same city to the music lover. Following his return to America he was for some years an instructor of drawing and painting at the Baltimore institution where he had obtained his early training. He also established himself as a portrait painter, but although several portraits were executed successfully, he found it rather dull and welcomed the opportunity offered in 1912 to become mycological artist to Prof. Farlow of Harvard University.

During the ten year period that ensued, he gave himself wholeheartedly to the study of the fleshy fungi and to their accurate portrayal in color, under Dr. Farlow's immediate and sympathetic guidance. He worked for the most part in the famous library which adjoined Prof. Farlow's home in Cambridge, but also spent much time at Chocorua, New Hampshire, the Farlow summer home, a well known spot mycologically. Several hundred plates now in the collections of the Farlow Herbarium attest his artistic ability and technical accuracy. Some 24 of these plates were issued in 1929 as part of the posthumus volume edited by Dr. Burt, *Icones Farlowianae,* the exact plates involved being listed by Krieger under this reference in the bibliography of his *Popular guide to the higher fungi of New York* (**14**). It was during this time also that he commenced the indexing of the world's literature of the larger fungi to which task he devoted most of his leisure hours for more than thirty years. His recreation while a resident of Cambridge was the Boston Symphony Orchestra and other local musical organizations. He not only enjoyed the musical performances of others, but was himself a skilled pianist and violinist and a great lover of Beethoven, Bach, and other composers of symphonic music.

Leaving Dr. Farlow's service late in 1912, to again accept employment with the United States Department of Agriculture, Krieger was assigned to the Plant Introduction Garden at Chico, California. Here under the direction of the late David Griffiths he painted a remarkable series of pictures of the innumerable species and forms of the Cactus family assembled by Griffiths in connection with his studies of the forage possibilities of the prickly pears. These plates, largely unpublished, are deposited in the National Herbarium of the Smithsonian Institution, as part of the Griffiths' collections.

Although Krieger developed a great admiration for David Griffiths and came to like Chico and its environs, the mushrooms were his first love, and he enthusiastically welcomed the invitation of Dr. Howard A. Kelly, of Baltimore, to resume his study and portrayal of these interesting plants. He took up his work with Dr. Kelly in December 1918, and during the ensuing ten years painted

a second superb series of mushroom plates and continued intensive efforts to make his index comprehensive. It was during this, the halcyon period of his career, that he prepared and published most of his technical papers which appeared in Mycologia and other scientific journals. Prominent among them was the article *Common mushrooms of the United States* (3) in the National Geographic Magazine for May 1920 which was illustrated by 16 of his own colored plates. This article attracted widespread favorable comment from mycologists and laymen alike, and it is still a " best seller " with bookdealers who handle the Geographic. Another extremely interesting and instructive paper was his history of mycological illustrations (7) which attested not only his ability as a critic of mycological illustration, but his knowledge of the literature. Other papers described and discussed new or rare agarics and other fungi encountered among the many species collected as " models " for his plates. A number of popular articles contributed to the Baltimore papers testified to the breadth of his interests.

Not the least of his activities was his assistance to Dr. Kelly who was interested during this time in building up what became within a few brief years one of the finest private mycological libraries ever assembled. It included an excellent set of Saccardo's Sylloge Fungorum, a volume of original colored illustrations by Schweinitz, and many other fine items to a total of over 10,000. Krieger's work with this library was climaxed by his detailed and accurate catalogue of it, published by Dr. Kelly in 1924.

In 1928 Dr. Kelly decided the time had arrived to deposit his mycological library and fungus collections, including the Krieger paintings in an institution where they would be safely housed and readily available for use. The University of Michigan was selected and the transfer made under the direction of the late C. H. Kauffman where in accordance with Dr. Kelly's wish the collection was named " The L. C. C. Krieger Mycological Library," and Krieger was appointed Honorary Curator. His connection with Dr. Kelly ceased at this time, but it must be noted that the latter continued his friendship with him, and aided him in many ways during his later years.

Krieger served briefly in 1928–29 with the Tropical Plant Research Foundation in Cuba where with his usual skill he made a series of paintings of sugar cane diseases, several of which were published. Returning from his Antillean adventure through the interest of Dr. Kelly he became Mycologist to the New York State Museum at Albany, his primary objective being the preparation of a manual of the higher fungi of New York State to be illustrated in part by some of his own paintings. He undertook the task with his usual enthusiasm and within a year prepared the manuscript and illustrations of the volume (**14**) which after a long unaccounted for delay was issued in 1935 by the New York State Museum. This book was well written, carefully illustrated, and scientifically accurate and is one of the most satisfactory of the popular mushroom manuals ever issued in this country. It brought him many favorable comments although his satisfaction in his work was marred by the fact that the originals of the plates for which he felt responsible were lost or destroyed through the negligence of others.

For the third time Krieger entered Government service in 1929, largely as a result of the interest taken in him by his old friend, David Griffiths, who was now concerned with the development of an American bulb-growing industry. The artist's talents were employed to illustrate in color the flowers of the many varieties of bulbous plants involved in the project, and a number of these plates appear in Griffiths' publications on the subject. Later on the work became more diversified to include a wide range of horticultural and pathological subjects and many colored plates bearing the initials L. C. C. K. will be found in the Market Disease Handbook series and other publications of the Division of Fruit and Vegetable Crops and Diseases issued during recent years.

Although circumstances did not permit him to work at his favorite subject, Krieger retained his interest in the fleshy fungi and more especially in the genus *Boletus*. He was particularly skilled in identifying species in this difficult group and had accumulated a comprehensive set of notes covering the literature of the genus with the hope of preparing a monograph to be illustrated by his paintings which included some 80 species.

Unfortunately this plan never came to fruition, the infirmities of age and lack of funds preventing. Among his other unfinished works may be mentioned a panchromatic color atlas and a partially completed set of paintings to illustrate a proposed low cost popular mushroom manual, both of which are deposited in the Mycological Collections of the Bureau of Plant Industry.

At the time of his death he was a member of the Mycological Society of America, the Botanical Society of Washington, the Deutsche Gesellschaft für Pilzkunde and an honorary member of the California Mycological Society. During his career he had been a member of the New England Botanical Club, the Boston Mycological Club, the Botanical Society of America, and the Maryland Academy of Science. He married Agnes Checkley Keighler, April 4, 1904. She died in 1939 under tragic circumstances, which were a contributory factor to his own passing. A daughter, Agnes Checkley Krieger survives.

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WASHINGTON, D. C.

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FOUR PHYCOMYCETES DESTRUCTIVE TO NEMATODES AND RHIZOPODS

CHARLES DRECHSLER

(WITH 5 FIGURES)

Agar plate cultures prepared in the isolation of oomycetes responsible for root rot and allied diseases of the higher plants often display, after aging a week or more, important biotic relationships among some of the various extraneous soil microörganisms that have managed to develop successfully in them. Pure cultures used in connection with studies on the morphology of the oomycetes in question—mainly species of *Pythium, Phytophthora,* and *Aphanomyces*—can often be made to display such relationships likewise if after serving their immediate purpose they receive an accession of decaying vegetable material. Through examination of cultures thus prepared, four additional Phycomycetes habitually subsisting by the destruction of minute terricolous animals have been discovered. While two of the additional forms differ from previously described members of the Zoöpagaceae only with respect to ordinary details of morphology, the other two forms reveal a type of asexual reproduction alien to all seven of the genera hitherto erected in the family. With accession of the four species herein to be described, the recorded membership of the Zoöpagaceae is increased to 42.

A NEMATODE-CAPTURING PHYCOMYCETE WITH INTRAMATRICAL LATERAL CHLAMYDOSPORES

In an earlier summary (**1**: p. 269, figs. 15C, 15D; p. 270, lines 7 to 19) a *Pythium*-like fungus was briefly set forth that captures nematodes by adhesion to unseptate mycelial filaments about 4 μ wide; the sigillate cushion of adhesive material operative in each instance of capture thereupon being pierced by an infective branch, which then penetrates the animal's integument and gives rise within the fleshy body to a system of assimilative hyphae. As regards

vegetative morphology and predaceous habit the fungus thus shows very obvious parallelism with the two robust nematode-capturing forms that I have elsewhere (**4**, **6**) described as members of the Zoöpagaceae under the binomials *Stylopage hadra* and *S. leiohypha*. However, its asexual reproduction by development of more or less intramatrical, mesially intercalary, globose conidia on creeping mycelial filaments differs rather markedly from the asexual reproduction by development of aerial conidia prevalent among the Zoopagaceae. Because of their resemblance to the asexual spores of some familiar species of *Pythium,* as, for example, *P. ultimum* Trow, the intercalary globose conidia might readily be held to indicate taxonomic relationship in the Pythiaceae, to which family, indeed, the predaceous genus *Zoöphagus* has been assigned by most writers; though a more convincing interpretation of them can be derived by considering the indubitably homologous reproductive bodies produced by another nematode-capturing Phycomycete.

This Phycomycete of less ambiguous morphology developed in some fifty *Pythium* cultures on maizemeal agar, to each of which had been added pinches of leaf mold from collections made during September 1939, near Butternut, Wis., and Haugen, Wis. Its hyphae, while of about the same width as those of *Stylopage hadra,* show little of the haphazard ramification usual in the latter species, but, instead, grow out from their origin in sparse radial arrangement, sometimes pursuing a straightforward course for stretches of 10 mm. without giving off more than a half-dozen branches. It subsists, seemingly to the exclusion of all other sources of nourishment, by preying on eelworms; *Pectus parvus* Bastian being found captured most abundantly in my cultures. Capture is effected by adhesion to outwardly undifferentiated mycelial hyphae, the adhesive material soon becoming visible as a sizeable cushion of sigillate shape and golden yellowish coloration. An infective branch now pierces the adhesive cushion, penetrates the animal's integument, and then ramifies several times (FIG. 1, *A, B*) in giving rise to assimilative hyphae that extend themselves lengthwise through the fleshy body (FIG. 1, *C, a, b; D–F*). Often an eelworm is held in two (FIG. 1, *B, E*) or three (FIG. 1, *F*) places, and is invaded by a corresponding number of haustorial systems. Once the assimilative hyphae, which as in *S. hadra* are perceptibly narrower than the

mycelial threads, have depleted the animal of its digestible substance, their protoplasmic contents are withdrawn into the parent filament by way of the infective branch. Before long the collapsed integument and the evacuated haustorial membranes within it disappear from view completely, so that only a cicatrized stub of the infective branch, more or less imbedded in yellowish material (FIG. 1, *B*), remains as evidence of the animal's destruction. Protuberant stubs of such origin are usually not difficult to distinguish from the small lumps of adhesive substance often secreted by mycelial hyphae in positions near captured animals (FIG. 1, *C, E*).

To initiate development of asexual spores the long mycelial hyphae burgeon forth lateral processes here and there. Each process increases in size as it receives granular protoplasm supplied through progressive evacuation of the adjacent proximal and distal portions of the parent hypha; successive steps in this evacuation being marked by deposition of consecutive retaining septa (FIG. 1, *G, H, I*). Movement of the granular material seems to be rather slow, and apparently becomes still slower after a stage has been reached when all but a short segment of the parent hypha, sometimes not more than 5 μ in length, has been evacuated (FIG. 1, *J, K*). In time, however, through gradual enlargement of a vacuole, this last hyphal segment likewise is emptied of protoplasm (FIG. 1, *L, M*), and a retaining wall is laid down whereby the evacuated filament is delimited from the sessile lateral body that constitutes the asexual spore (FIG. 1, *N–W*). Often, especially in elongated spores relatively narrow at the base, further withdrawal of protoplasm ensues, with the result that a unilocular or bilocular stalk-like basal part is also emptied of contents (FIG. 1, *X, Y, Z, AA*).

It is not evident that the stalk-like part, where present, serves to hold the reproductive body aloft in the air. Apparently the spores, whether stalked or sessile, are never formed as aerial structures, but are produced either in the substratum or directly on its surface. Unlike aerial conidia generally, including those of the Zoöpagaceae, they are not adapted for easy disarticulation. In the presence of active nematodes they sometimes secrete lumps of yellow adhesive material (FIG. 1, *Q*). On being transferred from stale cultures to comparatively fresh nematode-infested cultures, they germinate vegetatively by putting forth a sturdy hypha capable of capturing

prey. Irrigation with fresh water has not brought them to produce zoöspores. Their intramatrical origin, as well as their variability with respect to size and shape, distinguish them from the aerial conidia of the genus *Endocochlus,* which they resemble somewhat in manner of development. In view of their general characteristics they would seem to represent chlamydospores rather than conidia.

The morphology of its vegetative stage, together with its predaceous habit, leaves little doubt that the fungus must belong in the Zoöpagaceae. To make provision in the family for members reproducing asexually by the development of intramatrical chlamydospores, a new genus is now proposed under a name compounded of two words meaning "bladder" and "trap" respectively. The epithet chosen for the species refers, of course, to the position of the reproductive bodies in relation to the hyphae on which they are borne.

Cystopage gen. nov.

Mycelium hyalinum, plerumque parce ramosum; hyphis filiformibus, primo continuis, minuta animalia per adhaesionem capientibus, in ea penetrantibus, carnem eorum assumentibus, chlamydosporas terminalis vel intercalaris vel lateralis in matricem gignentibus.

Mycelium hyaline, usually rather sparingly branched; hyphae filamentous, at first continuous, capturing minute animals by adhesion, then penetrating into them and appropriating their fleshy contents; reproducing asexually by the development of terminal, intercalary, or lateral chlamydospores in or on the substratum.

Cystopage lateralis sp. nov.

Mycelium sparsum; hyphis 2.5–6 μ crassis, saepe recta procurrentibus, sine tuberibus vermiculos nematoideos tenentibus, integumentum eorum perforantibus, ramulos assumentis vulgo 2–3 μ crassos intus evolventibus qui carnem exhauriunt; chlamydosporis incoloratis, globosis, elongato-ellipsoideis, ovoideis, subinde lobulatis, plerumque 25–50 μ longis, 10–28 μ latis, semper a latere hyphae mycelii oriundis, fere sessilibus sed quandoque pediculo evacuato aptis.

Vermiculos nematoideos diversos praesertim *Plectum parvum* capiens consumensque habitat in humo silvestri prope Butternut, Wisconsin, et Haugen, Wisconsin.

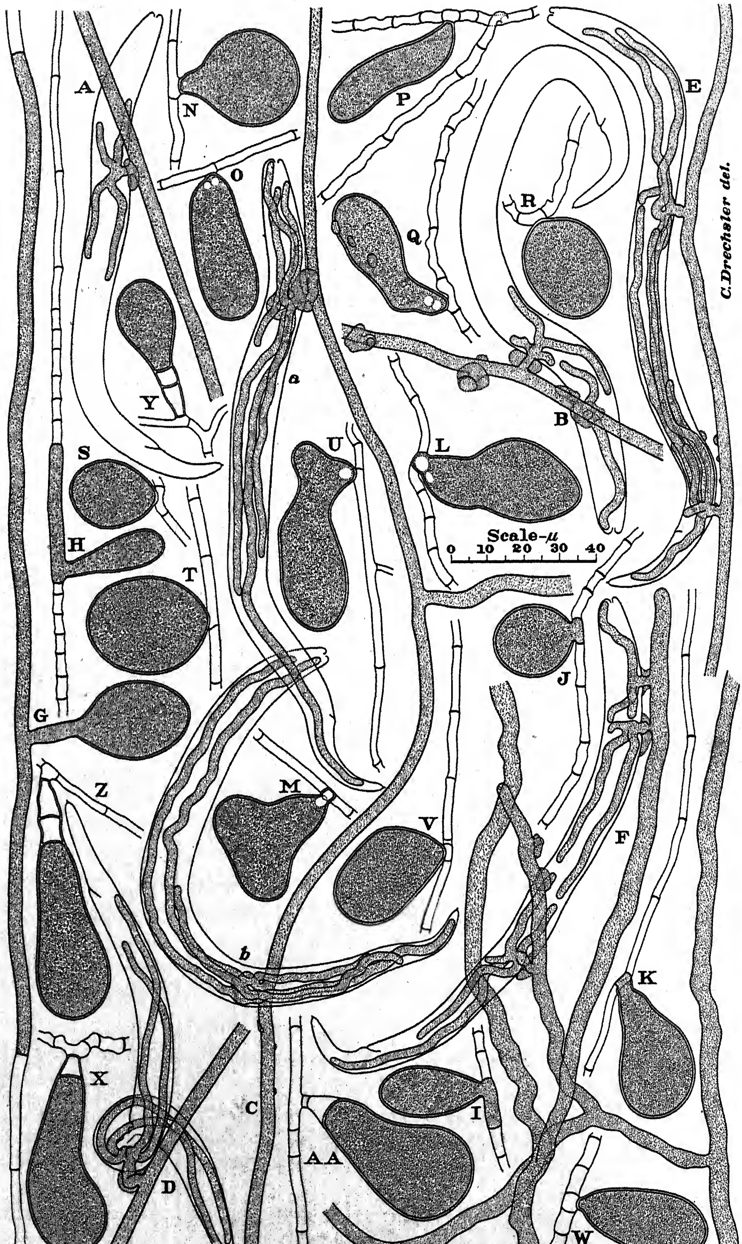

FIG. 1. *Cystopage lateralis.*

Mycelium sparse; hyphae 2.5 μ to 6 μ wide, often straightforward for several millimeters, through adhesion capturing nematodes, then invading them without production of orbicular protuberances, the infective branch giving rise within to haustorial filaments commonly 2 μ to 3 μ wide, which assimilate the fleshy contents. Chlamydospores colorless, globose, elongate-ellipsoidal, ovoid, or somewhat lobate in shape, measuring mostly 25 μ to 50 μ in length by 10 μ to 28 μ in width, always formed laterally on mycelial hyphae, commonly sessile, but sometimes, following evacuation of a narrow proximal part, coming to surmount an empty unilocular or bilocular pedicel.

Capturing various nematodes, including especially *Plectus parvus*, it occurs in leaf mold near Butternut, Wis., and Haugen, Wis.

A RHIZOPOD-CAPTURING PHYCOMYCETE WITH INTRAMATRICAL CHLAMYDOSPORES

One of the cultures in which *Cystopage lateralis* grew out from deposits of leaf mold afforded also the development of a more minute but unquestionably congeneric fungus. This smaller form subsisted, apparently to the exclusion of other nourishment, by capture of a protozoan, elongated elliptical in outline, and measuring mostly 25 μ to 30 μ in length by 11 μ to 15 μ in width. When the animal, present abundantly both on and in the maizemeal-agar medium, first came under observation it was very inactive, and had at its anterior end a median indentation (FIG. 2, *A, B*) that gave it a frontal profile reminiscent of some flagellate protozoans belonging, for example, in the saprozoic genus *Chilomonas*. After portions of the material had been irrigated with fresh water the animal resumed a more active condition by largely obliterating its indentation and by extending from its median anterior region a branching system of delicate pseudopodial strands (FIG. 2, *C, D*). Though a membranous testa was not clearly distinguishable, the relatively stable conformation of the protozoan indicated the presence of a firm envelope. A spherical nucleus, about 7 μ in diameter, and of an indistinctly granular structure throughout, usually occupied a position near the fundus (FIG. 2, *A, C, D*), though occasionally it could be seen nearer the middle of the body (FIG. 2, *B*). The animal apparently is referable to the genus *Lecythium*

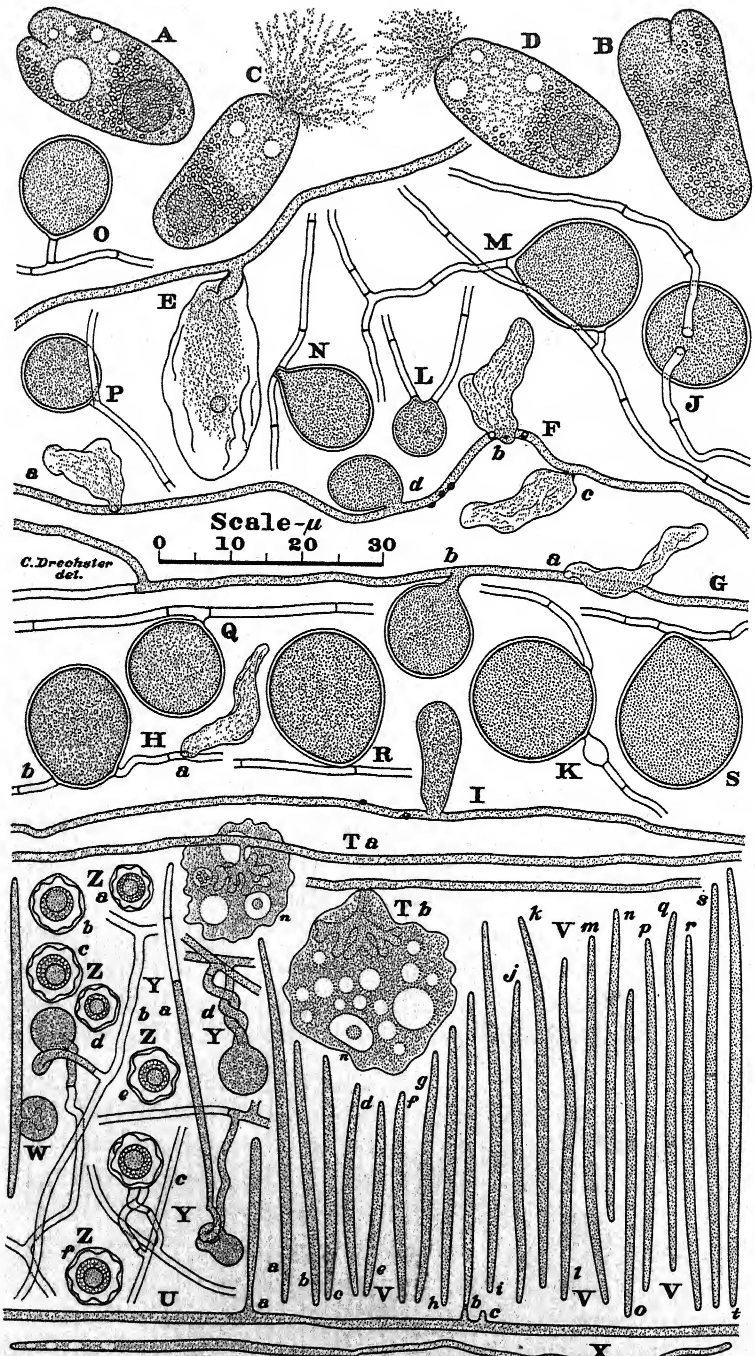

FIG. 2. *A–S, Cystopage subtilis; T–Z, Acaulopage stenospora.*

among the testaceous rhizopods, and in that genus would seem perhaps most similar to *L. mutabile* (Bailey) Hopk.

When specimens of the rhizopod have been captured by adhesion to the delicate mycelial hyphae of the fungus, they are soon expropriated of all protoplasmic contents. This is evidently accomplished by means of commonplace haustorial branches, though, owing to an unfavorable consistency of the sarcode, such elements are in most instances only partially and indistinctly discernible (FIG. 2, *E*). The emptied testae remain attached to the hyphae as collapsed membranous envelopes (FIG. 2, *F, a, b, c; G, a; H, a*) not differing in appearance from collapsed pellicles of soil amoebae.

The fungus often initiates asexual reproduction, much like *Cystopage lateralis,* by putting forth lateral excrescences from its mycelial filaments (FIG. 2, *F, d; G, b; I*). In addition, the protoplasm of vegetative hyphae here often accumulates in intercalary swellings, or in swellings formed terminally on short lateral branches; so that when the adjacent portions of mycelium have yielded up their contents, subspherical chlamydospores are delimited in intercalary (FIG. 2, *H, b; J–M*), laterally intercalary (FIG. 2, *N*), and terminal (FIG. 2, *O*) relationships as well as in lateral (FIG. 2, *P–S*) relationship to the evacuated filaments. A very dense, almost imperceptibly granular internal texture, together with a faint smoky cast, gives the asexual spores an appearance suggestive of the ectoparasitic thalli of *Bdellospora helicoides* Drechsl. (2).

Differing markedly from *Cystopage lateralis* not only by its generally smaller dimensions, but also by the more varied mycelial relationships and more regularly subspherical shape of its chlamydospore, the fungus is described as a new species under a specific name having reference to the slenderness of its hyphae.

Cystopage subtilis sp. nov.

Mycelium sparsum; hyphis 1–1.5 μ crassis, parce ramosis, per adhaesionem animalcula tenentibus, protoplasma eorum assumentibus; chlamydosporis incoloratis vel minime fumidis, lateralibus vel intercalaribus vel rarius terminalibus, globosis vel paululum obovoideis, plerumque 7–20 μ diam.

Speciem *Lecythii* (*Lecythii mutabilis* adfinem) capiens consumensque habitat in humo silvestri prope Haugen, Wisconsin.

Mycelium sparse; hyphae 1 μ to 1.5 μ wide, sparingly branched, capturing minute animals through adhesion, and assimilating their protoplasmic contents; chlamydospores colorless or very faintly smoky, lateral or intercalary or more rarely terminal, subspherical or slightly obovoid, measuring commonly 7 μ to 20 μ in diameter.

Capturing and consuming a species of *Lecythium*, close to or possibly identical with *L. mutabile*, it occurs in leaf mold near Haugen, Wis.

ANOTHER SPECIES OF ACAULOPAGE WITH LONG SLENDER CONIDIA

A maizemeal agar culture to which had been added some pinches of leaf mold collected in Arlington, Va., on Oct. 7, 1936, permitted the development of a species of *Acaulopage* that with respect to morphology would seem approximately intermediate between the two forms I described earlier (3) under the binomials *A. rhaphidospora* and *A. macrospora*. It subsists by capturing amoebae that usually measure 15 μ to 25 μ in diameter, and that usually contain a subspherical or ellipsoidal hyaline nucleus, often 4 μ to 6 μ long and 3.5 μ to 4 μ wide, within which a slightly darker "Binnenkörper," about 1.8 μ in diameter, is distinguishable (FIG. 2, *Ta, n; Tb, n*). Capture is effected by adhesion to mycelial filaments markedly coarser than those of *A. rhaphidospora,* even if the differences in width amounts to less than a micron. The pellicle of the individual captive is soon pierced by a narrow infective branch, which after growing a short distance into the sarcode bifurcates several times to form a pedicellate haustorium with swollen digitate assimilative elements. The animal's contents become increasingly vacuolate (FIG. 2, *T, b*) and eventually disappear completely.

With adequate nourishment the superficial hyphae of the fungus send up erect filamentous processes (FIG. 2, *U, a*) each of which, on attaining definitive length, undergoes division into a long slender aerial conidium and a short basal sterigma (FIG. 2, *U, b, c*). In general, the conidia thus formed (FIG. 2, *V, a–t*) are longer but not wider than the homologous bodies of *Acaulopage rhaphidospora*. On the whole, again, they are appreciably narrower and shorter than the conidia of *A. macrospora,* and would seem to be lacking, besides, in any tendency either toward distal bifurcation or toward

evacuation at the ends. A conidium, after falling on the substratum, often begins predaceous activity directly by intruding a haustorium into an amoeba adhering to it (FIG. 2, *W*). Germination regularly takes place by emission of a germ hypha (FIG. 2, *X*) capable of holding prey.

The germ tube from a conidium often assumes a sexual function by uniting with a zygophoric branch from a mycelial hypha to initiate development of a zygosporangium (FIG. 2, *Y, a*). In these instances, as also when the paired zygophoric branches arise from two separate mycelial hyphae (FIG. 2, *Y, b, c*), some meager reciprocal engagement of the conjugating elements is usual. This engagement only occasionally appears as helicoid intervolution (FIG. 2, *Y, d*). The zygosporangium formed at the junction of the sexual branches is a smooth subspherical body. At maturity its envelope collapses about the prominently warty zygospore formed within it (FIG. 2, *Y, c; Z, a–f*). Both zygosporangium and zygospore are noticeably larger than the corresponding structures of *A. rhaphidospora.*

A term compounded of two words meaning "narrow" and "seed," respectively, is deemed a suitable specific name for the fungus.

Acaulopage stenospora sp. nov.

Mycelium sparsum; hyphis incoloratis, filiformibus, parce ramosis, 1–1.5 μ crassis, ad animalcula haerentibus, pelliculam eorum perforantibus, haustorium intus evolventibus quod protoplasma exhaurit; haustorio pediculato, pediculo circa 2–3 μ longo, .7 μ crasso, apice abrupte latescente, vulgo bis vel ter repetite bifurco, ita usque 8 ramulos divaricatos, circa 1.3 μ crassos ferente. Conidia hyalina, filiformia, recta vel leniter curvata, utrimque parvo attenuata; plerumque 25–60 μ longa, 1.2–1.6 μ crassa, ex sterigmatibus circa 2 μ altis et 1 μ latis assurgentia. Hyphae zygosporiferae modo ex hypha mycelii modo ex conidio germinanti oriundae, vulgo 10–30 μ longae, 1–1.5 μ crassae, saepius inter se paulum intricatae; zygosporangio primum levi, sphaeroideo, 6–8 μ diam., maturitate membrana circa zygosporam laxe collapsa; zygospora flavida, globosa, 5.5–7.5 μ diam., membrana .5–1.5 μ crassa, 10–25 verrucis ornata.

Amoebas 5–25 μ latas capiens consumensque habitat in humo silvestri in Arlington, Virginia.

Mycelium sparse; hyphae colorless, filiform, sparingly branched, 1 μ to 1.5 μ wide, adhering to minute animals, perforating the pellicle of each captive, and intruding a haustorium into the sarcode;

haustorium pedicellate, its pedicel, about 2 μ to 3 μ long and 0.7 μ thick, widening abruptly and usually bifurcating successively 2 or 3 times to bear as many as 8 divergent branches about 1.3 μ wide. Conidia colorless, filiform, straight or slightly curved, tapering somewhat at both ends, measuring mostly 25 μ to 60 μ in length by 1.2 μ to 1.6 μ in greatest width, borne erect on sterigmata about 2 μ high and 1 μ wide. Zygophoric hyphae commonly 10 μ to 30 μ long, 1 μ to 1.5 μ wide, usually only rather slightly intricated, arising from mycelial filaments or from germinating conidia; zygosporangium subspherical, 6 μ to 8 μ in diameter, at first smooth, its envelope at maturity collapsing loosely about the zygospore; the latter yellowish, globose, 5.5 μ to 7.5 μ in diameter, surrounded by a wall measuring 0.5 μ to 1.5 μ in thickness inclusive of its 10 to 25 warty protuberances.

Capturing and consuming Amoebae 5 μ to 25 μ wide it occurs in leaf mold in Arlington, Virginia.

A SPECIES OF COCHLONEMA WITH IRREGULARLY CONVOLVED THALLI

In a maizemeal agar culture to which had been added small quantities of leaf mold collected near Haugen, Wis., during September 1939, numerous large amoebae were found parasitized by a species of *Cochlonema* whose luxuriant tufts of conidial chains become visible to the naked eye as minute white flecks distributed here and there over the surface of the medium. The animals attacked commonly measured 60 μ to 75 μ in diameter when drawn into a more or less compact form, and were surrounded by a relatively thick pellicle cast in broad, boldly undulating pseudopodial folds. They consistently revealed imbedded in the granular sarcode a prolate ellipsoidal nucleus (FIG. 3, *A, n; B, n*), often about 15 μ long and 12 μ to 14 μ wide, within which a lighter hyaline outer layer could be distinguished from a slightly darker subspherical central body, or "Binnenkörper," approximately 6 μ in diameter. All the animals attacked clearly belonged to the same species of *Amoeba* that earlier was recorded (5, 9) as being subject to destruction by the two fungi I described under the binomials *Dactylella tylopaga* and *Cochlonema megalosomum*. This species of *Amoeba* was designated in my earlier papers as *A. verrucosa* Ehrenb., and consistency, at least, will be served by applying the same name also in the present account.

The host animal unwittingly initiates its own destruction by ingesting conidia of the parasite strewn about on the surface of the substratum. Each ingested spore soon germinates in extending, usually from near one of its ends, a delicate germ tube that gradually widens as it elongates (FIG. 3, *A, a, b*). However, the young thallus is ordinarily not left to batten undisturbed, for during the earlier stages of infection, the contractile vacuole of the host repeatedly expands in contact with it. In instances of plural infection the expanding vacuole often engages several young thalli, which then usually become more or less entangled with one another (FIG. 3, *B, a, b, c*). Discharge of the contractile vacuole abruptly moves the engaged thalli to a peripheral position in the sarcode, whence the animal seemingly attempts to void them by means of a purse-lipped protrusion (FIG. 3, *A*). On failure of the attempt the enlarging contractile vacuole engages the thalli anew in another effort at their expulsion. Although no instances of successful voidance came under observation, it seems not unlikely that defensive efforts so persistent may at times have a favorable issue. At all events the animal's apparent determination to resist destruction by the parasite under discussion contrasts markedly with its submissive attitude towards *Cochlonema megalosomum,* as well as with the resigned behavior of numerous other rhizopods towards zoopagaceous forms subsisting on them. The show of resolute opposition recalls Penard's (**10**) early record of successful defensive action by *Amoeba alba* Greeff in eliminating, through abstriction, sizable thalli of the fungus that he designated as *Saprolegnia* B, and that almost certainly must have been a member of the Zoopagaceae.

While it remains uncertain whether any morphological effect can be attributed to the stretching action exerted by the repeated expansion of the contractile vacuole, there can be no doubt that the narrow proximal portion of the thallus is much more prolonged in the fungus under consideration than in related species. It appears more probable that the morphology of the parasite may be influenced somewhat directly by the "rolling" locomotion of the animal. Because of such locomotion the growing thallus is constantly tumbled about, with the result that its tendency toward spiral convolvement, rather clearly expressed through the stages of

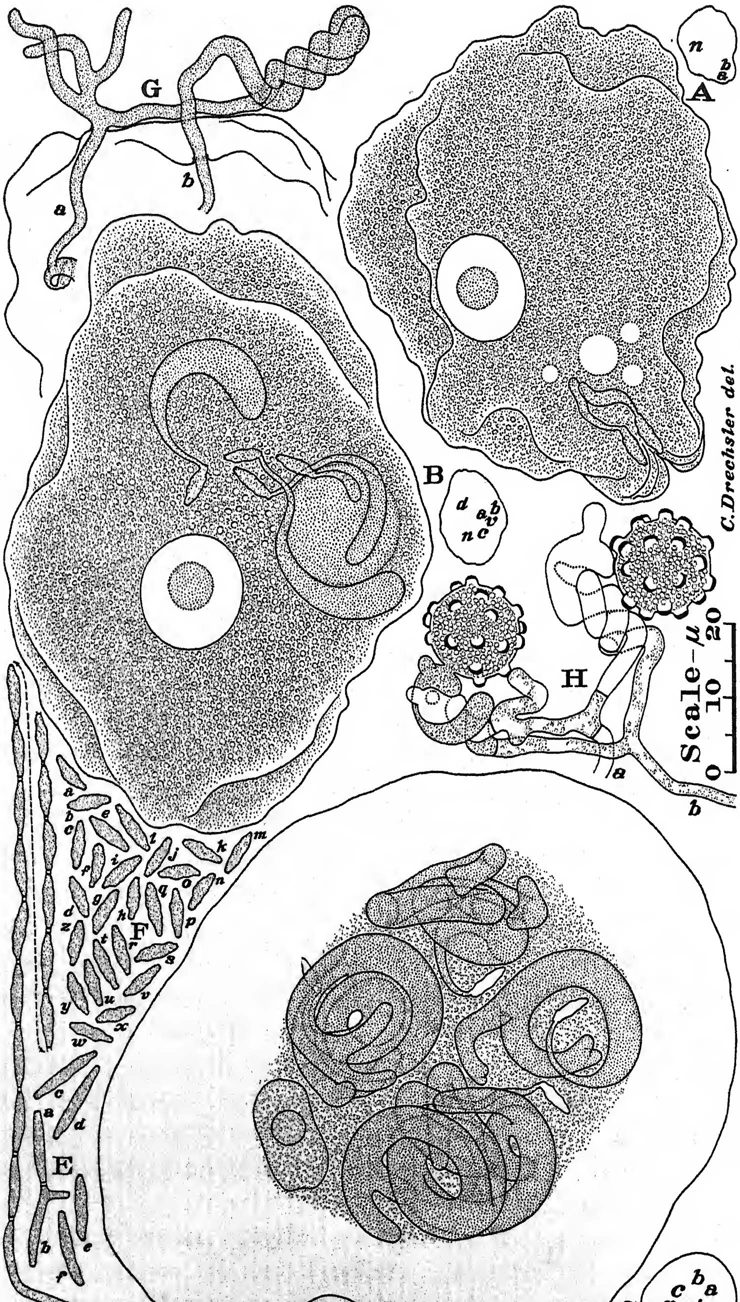

FIG. 3. *Cochlonema symplocum.*

elongation marked by the first and second dichotomies (FIG. 3, *B, d; C, a, b, c*), shows increasing irregularity in the further growth increments present in the relatively large clew-like thallodic coils having three successive bifurcations (FIG. 3, *C, d;* FIG. 4, *A, a, b*). The appearance of disorderly development is heightened in plurally infected animals, since here the several thalli very often become intertangled into a confused snarl. In any case, regardless of the number of thalli at hand, the protoplasm of the amoeba undergoes steady reduction. The degenerating host nucleus remains recognizable until an advanced stage of expropriation has been reached (FIG. 3, *C, n*), but ultimately it, too, disappears from view (FIG. 4, *A*).

As has been intimated, the parasite gives rise to scattered white tufts consisting of long intertangled conidial chains. In the individual chain the component conidia are found united by short empty isthmi (FIG. 3, *D*). The spores in the lower portions of a chain (FIG. 3, *E, a–f*) are generally longer, narrower, and less pronouncedly verrucose than those in the median and distal portions (FIG. 3, *F, a–z*). Examination of asexual reproductive apparatus in earlier stages of development revealed that the chains are formed by segmentation of erect filaments whose smooth basal portions are little given to variations in width, but whose verrucose median and distal portions consist of expanded parts alternating with contrictions (FIG. 4, *B, a*). The number of conidiiferous filaments or of conidial chains in a tuft, often between 8 and 12, is governed mainly by the size of the host animal, rather than by the number of thalli responsible for its destruction. Apparently each thallus puts forth a single reproductive hypha, which, after growing through the host pellicle, branches out laterally to give rise to conidiiferous filaments in such numbers as the quantity of available protoplasm permits: two, three, or perhaps four coming from thalli of moderate size that had been constrained to share the substance of their host with several fellows (FIG. 4, *B, a–c; d–f; g–h*); ten or perhaps more coming from thalli that had undergone no competition.

Sexual reproduction of the parasite was not observed in the culture for several days, until rather suddenly, while the material was being studied, it began simultaneously on an extensive scale. The

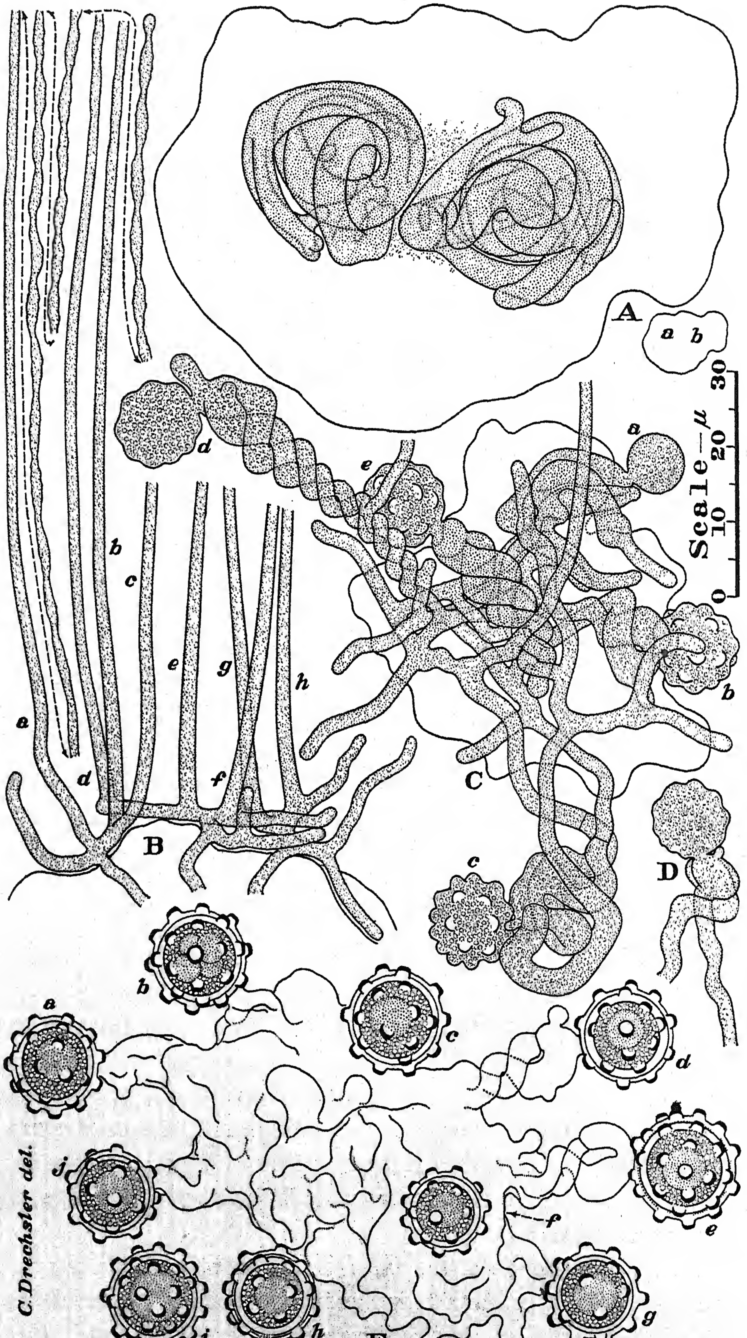

FIG. 4. *Cochlonema symplocum.*

abrupt turn from asexual development probably was due to a marked fall in the temperature of the laboratory, resulting accidentally from failure of the heating system during cold weather. Apparently the fungus, like most other endoparasitic members of the Zoöpagaceae, is heterothallic, since its zygospores have been found produced only around pellicles occupied by plural thalli, and since, moreover, paired zygophoric hyphae have regularly been found arising from separate thalli wherever their connections were not too badly obscured through excessive intrication of vegetative and reproductive parts (FIG. 3, *G, a, b; H, a, b;* FIG. 4, *C*). With respect to origin the zygophoric hypha is closely similar to the conidiiferous filament, as it likewise either represents a branch given off outside the pellicle by the single reproductive filament arising from the proximal portion of a thallus (FIG. 3, *G, a*), or consists of an external prolongation of the reproductive filament (FIG. 3, *G, b*). On making contact with each other paired zygophoric hyphae continue to grow, widening rather markedly and often winding about one another in as many as five helicoid turns before fusing apically (FIG. 3, *G, H;* FIG. 4, *C, d, e*). Where the sexual hyphae are not spirally intervolved, they usually show some reciprocal engagement of a more irregular kind (FIG. 4, *C, a, b, c; D*). A septum is laid down in each hypha, cutting off all or most of its widened intervolved terminal portion as a gametangium (FIG. 3, *G*). From the place of union between the sexual elements, or in close proximity thereto, the zygosporangium buds forth as a subspherical body, smooth during its earlier stages of enlargement (FIG. 4, *C, a*), but later becoming rather boldly verrucose (FIG. 4, *C, b–e; D*); one or both of the gametangia often giving rise, in the meantime, to a distal diverticulum of variable size (FIG. 4, *C, d*). When the zygosporangium has received the entire contents of the two gametangia, it lays down a basal septum (FIG. 3, *H*), and forms internally a zygospore surrounded by a wall rather indistinctly separated from its own (FIG. 4, *E, a–j*). At maturity the zygospore reveals a central reserve globule (FIG. 4, *E, a, c–j*), or occasionally several reserve globules (FIG. 4, *E, b*), surrounded by a coarsely granular parietal layer.

The fungus invites comparison more especially with *Cochlonema verrucosum* Drechsl. (2). As that species was described from a

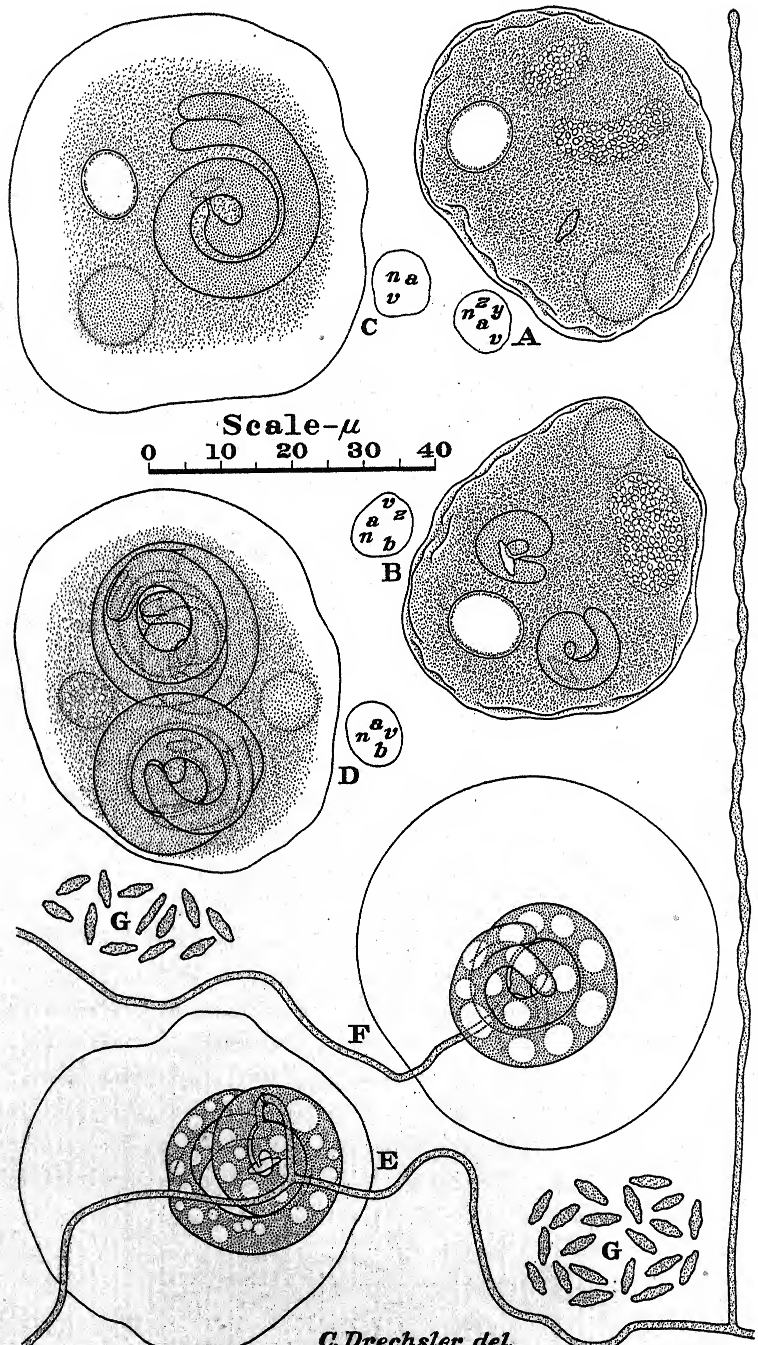

FIG. 5. *Cochlonema verrucosum.*

single culture in which the few specimens of the host animal remaining alive when observations began were already in advanced stages of infection, it may be opportune to give some further details obtained through examination of material in a culture subsequently prepared with leaf mold originating from Arlington, Va., late in October 1937. During early stages of infection, before any pronounced pathological changes had become apparent, the rather slightly prolate nucleus of the host amoeba contained close under its delimiting membrane a narrow, somewhat interrupted layer of perceptibly darker material (FIG. 5, *A, n; B, n; C, n*). In its normal internal organization, therefore, the nucleus here would seem to resemble the larger and conspicuously more prolate nucleus of *Amoeba terricola* Greeff (*sensu strictiore*), the animal set forth in previous papers as subject to destruction by three zoöpagaceous forms I described under the names *Endocochlus gigas* (7), *Cochlonema megaspirema* (8), and *Acaulopage marantica* (9). Most assuredly, at all events, it differs in internal organization from the nucleus of *Amoeba verrucosa*. Apart from nuclear morphology, the host of *C. verrucosum,* provisionally identified as *Amoeba sphaeronucleolus* Greeff, appears clearly distinguishable from both *Amoeba terricola* and *Amoeba verrucosa* by its smaller dimensions and its thinner, more delicately undulous pellicle.

Although in the later material of *Cochlonema verrucosum* some thalli were found that had made nearly three spiral turns (FIG. 5, *D, a, b; E; F*) and had bifurcated once or twice, the distal coils showed no less geometrical symmetry than the proximal coils. At its proximal end the individual thallus always widened out abruptly from a short delicate germ tube. The single reproductive hypha produced by it was appreciably less robust than the corresponding filament in the related parasite from Wisconsin; and the conidia (FIG. 5, *G*) formed through segmentation of aerial branches put forth by this hypha appeared to be of somewhat smaller size than the asexual spores of the congeneric species.

The fungus from Wisconsin is therefore presented as a new member of the genus *Cochlonema*. An epithet meaning "interwoven" or "entwined" is deemed aptly descriptive both of its vegetative and of its sexual stage.

Cochlonema symplocum sp. nov.

Hyphae alitae 2.5–6.5 μ latae, basi paulatim latescentes, vulgo semel vel ter dichotomae, semel vel ter spiraliter convolutae vel saepe irregulariter glomeratae. Conidia hyalina, plerumque verrucosa, fusoidea, utrimque obtusa, 6–12 μ longa, 1.5–2 μ crassa, in catenulas assurgentis saepius circa 500 μ longas digesta, in quaque catenula vulgo quinquagena usque septuagena. Hyphae zygosporiferae 20–50 μ longae, basi circa 2 μ crassae, sursum latescentae, apice 4–5 μ crassae, binae ex duabus hyphis alitis enatae, saepius bis subinde etiam quinquies inter se circumplicantes. Zygosporangia sphaeroidea, saepius 11–14 μ crassa, 20–35 verrucis applanatis 1 μ altis 1.8 μ latis ornata. Zygosporae flavidae, membrana paene cum membrana zygosporangii concreta, loculum 8–10 μ crassum circumdante.

Amoebam verrucosam enecans consumensque habitat in humo silvestri prope Haugen, Wisconsin.

Vegetative hyphae 2.5 μ to 6.5 μ in diameter, usually widening very gradually at the base rather than abruptly, simple or more often repeatedly dichotomous up to 3 times, sometimes wound into a fairly regular spiral coil of 1 to 3 turns, and sometimes convolved into a rather irregular clew. Conidia hyaline, mostly warty, spindle-shaped, blunt at both ends, 6 μ to 12 μ long, 1.5 μ to 2 μ wide, commonly formed in numbers from 50 to 70 in fairly erect chains measuring often about 500 μ in length. Zygophoric hyphae 20 μ to 50 μ long, approximately 2 μ in diameter at the base, widening to a diameter of 4 μ to 5 μ at the apex, those of each conjugating pair arising from separate vegetative hyphae, and often winding about one another in 2 or even as many as 5 helicoid turns. Zygosporangium formed close to junction of the sexual hyphae, usually 11 μ to 14 μ in diameter, ornamented with 20 to 35 warty protuberances which are somewhat flattened on top and measure about 1 μ in height by 1.8 μ in basal width; its envelope often not distinctly separated from the wall of the yellowish zygospore, wherein is contained a spherical protoplast 8 μ to 10 μ in diameter.

Destroying *Amoeba verrucosa* it occurs in leaf mold near Haugen, Wis.

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EXPLANATION OF FIGURES

FIG. 1. *Cystopage lateralis;* drawn to a uniform magnification with the aid of a camera lucida; × 500 throughout. *A,* Portion of mycelial filament with a captured specimen of *Plectus parvus;* an infective branch has penetrated into the nematode, and is extending assimilative hyphae through the fleshy interior. *B,* Portion of mycelial filament with a captured specimen of *P. parvus;* into the animal have been intruded two infective branches both of which are extending assimilative hyphae through the fleshy body; on the mycelial filament are shown imbedded in deposits of adhesive material cicatrized stumps of two infective branches. *C,* Portion of a long mycelial filament on which two specimens, *a* and *b*, of *P. parvus* have been captured; each of the animals is permeated internally by a haustorial system extending from head to tail. *D,* Portion of mycelial filament with a captured specimen of *P. parvus;* assimilative hyphae have been extended almost throughout the contorted body of the captive. *E,* Portion of mycelial filament from which two haustorial systems have been extended into a captured specimen of *P. parvus;* three small lumps of adhesive material are shown attached to the mycelial filament, and one lump is shown adhering to the animal's integument. *F,* Portion of mycelium whereon a specimen of *P. parvus* has been captured by adhesion in three places; three haustorial systems are being extended into the fleshy body. *G,* An extensive portion of mycelial filament that is giving rise to a stalked chlamydospore. *H, I,* Portions of mycelial filaments showing rather advanced stages in migration of hyphal contents into lateral chlamydospores of relatively small size. *J–M,* Late stages in migration of hyphal contents into lateral chlamydospores; only a short seg-

ment of the parent filament remains continuous with each of the developing spores. *N–W*, Chlamydospores wholly lateral in position, no longer including any portion of the parent filament; one specimen, *Q*, has three lumps of adhesive material attached to it. *X*, Chlamydospore connected with the parent filament by an empty basal cell. *Y, Z, AA*, Chlamydospores connected to the parent filament by two empty basal cells resulting from progressive evacuation of basal portions.

FIG. 2. Drawn to a uniform magnification with the aid of a camera lucida; × 1000 throughout. *A–S: Cystopage subtilis. A, B*, Specimens of the protozoan prey, possibly *Lecythium mutabile* (Bailey) Hopk., as found in a rather dry agar medium. *C, D*, Specimens of the protozoan prey 12 hours after moistening the agar medium with fresh water. *E*, Portion of hypha on which a specimen of the protozoan has been captured. *F*, Portion of hypha to which are attached membranous remains of three captured animals, *a–c*, as well as four lumps of adhesive material; a chlamydospore, *d*, is shown in an early stage of development. *G*, Portion of a branching hypha with membranous remains of a captured animal, *a;* a young chlamydospore, *b*, is being formed terminally on a short stalk. *H*, Portion of an empty hypha, to which is attached the collapsed envelope of a captive, *a;* and on which is borne a mature, laterally intercalary chlamydospore, *b*. *I*, Portion of hypha with a chlamydospore in early stage of development; two small lumps of adhesive material are shown attached. *J–M*, Portions of empty hypha, each bearing a mature intercalary chlamydospore. *N*, Portion of empty hypha with a mature chlamydospore in laterally intercalary relationship. *O, P*, Portions of empty hyphae, each with a mature chlamydospore borne terminally on a short lateral spur. *Q, R, S*, Portions of empty hyphae, each bearing laterally a mature sessile chlamydospore.

T–Z: Acaulopage stenospora. T, a, b, Portions of mycelial filament, from each of which a dichotomously branching haustorium has grown into a captured amoeba; *n*, nucleus of each captive. *U*, Portion of superficial hypha bearing a conidium, *a*, in early stage of development, as well as a fully formed conidium, *b*, and a denuded sterigma, *c*. *V, a–t*, Conidia showing variations in size and shape. *W*, Conidium from which a small haustorium has been intruded into a minute amoeba adhering to it. *X*, Conidium germinating by the production of a germ hypha. *Y*, Four units of sexual apparatus showing: *a*, early stage in development of a zygosporangium, following union of a sexual hypha contributed by a germinating conidium with a sexual branch arising from a mycelial filament; *b*, immature zygosporangium formed by union of paired sexual branches arising from separate mycelial filaments; *c*, mature zygosporangium originating from conjugation of paired sexual branches contributed by two separate mycelial filaments; *d*, immature zygosporangium formed at junction of two zygophoric branches that wind about one another more extensively than is usual in the species. *Z, a–f*, Mature zygospores, enveloped in the zygosporangial membrane, showing differences in size and sculpturing.

FIG. 3. *Cochlonema symplocum*, drawn to a uniform magnification with the aid of a camera lucida; × 1000 throughout. *A*, Specimen of *Amoeba verrucosa* infected with two germinating conidia, *a* and *b*, which it apparently is attempting to void; *n*, nucleus of host animal. *B*, Specimen of *A.*

verrucosa infected with four young thalli of the fungus, *a–d; n,* host nucleus; *v,* contractile vacuole of host. *C,* Disabled specimen of *A. verrucosa* whose protoplasmic materials have been largely appropriated by four thalli of the parasite, *a–d; n,* host nucleus in somewhat degenerate condition. *D,* A sporiferous hypha bearing a long chain of conidia, of which only the lowermost 15 individuals are shown. *E, a–f,* Longish conidia from basal portion of conidial chains; the presence of a spur in *b* being due to branching of the sporogenous filament. *F, a–z,* Conidia from median and distal portions of chains, showing variations in size and shape. *G,* Pair of intertwined zygosporic hyphae that have their origin in the separate reproductive filaments *a* and *b*. *H,* Two units of sexual apparatus with full grown zygosporangia, each resulting from union of paired zygophoric hyphae coming from the separate reproductive filaments *a* and *b*.

FIG. 4. *Cochlonema symplocum,* drawn to a uniform magnification with the aid of a camera lucida; × 1000 throughout. *A,* Pellicle of a specimen of *Amoeba verrucosa,* whose protoplasm, except for a meager remnant, has been consumed in the development of the two large thalli *a* and *b*. *B,* Origins of eight growing conidiiferous hyphae, *a–h; a–c* resulting from ramification, outside the host pellicle, of one reproductive hypha; *d–f* resulting from branching of a second reproductive hypha; *g* and *h* resulting from ramification of a third reproductive hypha. One of the eight hyphae, *a,* is shown completely in four parts connected by broken lines. *C,* Five immature zygosporangia, *a–e,* derived from union of paired zygophoric hyphae having separate origins; at both *a* and *c* a supernumerary zygophoric hypha is present, though not functional. *D,* Young sexual unit with little intervolution of zygophoric hyphae. *E,* Ten mature zygospores, *a–j,* surrounding the collapsed pellicle of a large specimen of *A. verrucosa.*

FIG. 5. *Cochlonema verrucosum,* drawn to a uniform magnification with the aid of a camera lucida; × 1000 throughout. *A,* Specimen of host amoeba in active condition: *a,* ingested conidium of parasite; *n,* nucleus of host animal; *v,* contractile vacuole; *y, z,* digestive vacuoles containing numerous ingested bacteria. *B,* Specimen of host amoeba in active condition: *a, b,* two small thalli of the parasite, with empty conidial envelopes attached to them; *n,* host nucleus; *v,* contractile vacuole; *z,* large digestive vacuole containing numerous ingested bacteria. *C,* Specimen of host amoeba nearly disabled from loss of contents: *a,* thallus of parasite; *n,* host nucleus; *v,* contractile vacuole. *D,* Specimen of host amoeba nearly disabled as result of infection: *a, b,* two large thalli of parasite; *n,* degenerating host nucleus with lumpy internal structure; *v,* contractile vacuole. *F,* Thallus of parasite from which a reproductive filament has grown out through the enveloping pellicle of the host to produce conidial chains externally. *E,* Well developed thallus from which a reproductive filament has grown out to produce erect conidiiferous hyphae, of which one is shown. *G,* Detached conidia, showing variations in size and shape.

STUDIES IN THE GASTEROMYCETES II. BOVISTINA, A NEW GENUS

W. H. LONG AND DAVID J. STOUFFER

(WITH 1 FIGURE)

The Gasteromycete here described was discovered by the writers while on a collecting trip in the Woodland Forest type near Corona, New Mexico. The plant was mistaken for a *Bovista* hence did not attract any special attention when collected. Sixty plants were found scattered over several yards in the old exposed duff of a Juniper which had been recently removed for cord wood. Four other specimens were also obtained in the same general region.

The plant externally is a typical *Bovista,* but internally it has the glebal characters of a *Geaster;* a very unique combination and one not previously known to science. It is therefore made the type of a new genus.

Bovistina gen. nov.

Sporophore irregular globose (FIG. 1, *B, D*) to depressed-globose (FIG. 1, *A, C, E*), sessile; *peridium* of two distinct layers (FIG. 1, *A, E*) an exoperidium and an endoperidium; *exoperidium* membranous, deciduous at maturity; *endoperidium* membranous or papyraceous, with a metallic luster, dehiscing by a single, apical orifice, sterile base none; *gleba* of capillitium and spores; *capillitium* of long, unbranched, *Geaster*-like threads arising from the inner walls of the endoperidium, non-septate, colored; *spores* globose, continuous.

Forma, habitas et peridium ut in genere *Bovistae;* gleba e capillitio et sporis constans; capillitium e filamentis longis, simplicibus, his *Geastri* similibus, e parietibus interioribus endoperidii ortis, eseptatis, coloratis compositum; sporae globosae, continuae, coloratae.

Bovistina atrogleba sp. nov.

Sporophore 1–3 cm. in diameter, hypogeous, usually depressed-globose, with a universal mycelium; *exoperidium* with scattered particles of soil adhering to entire surface which easily rub off,

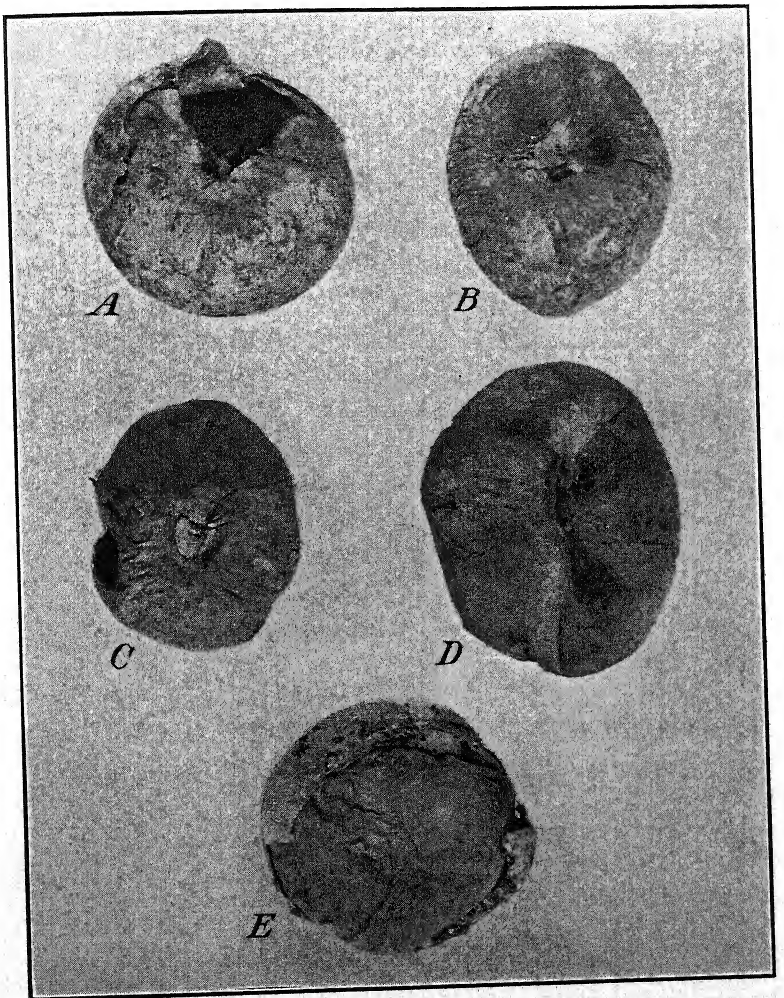

FIG. 1. *Bovistina atrogleba.*

white aging to light tan, brittle, up to 0.25 mm. thick, slowly flaking away at maturity (FIG. 1, *E*); *endoperidium* very thin, easily torn, flaccid, papyraceous, smooth, dull lead-colored, dehiscing by an irregular to elliptical plane to depressed, naked mouth (FIG. 1, *A, B, C*), which may become large and strongly lacerate with age (FIG. 1, *A, D*), often with small, white, floccose fragments of the exoperidium clinging to the margin of the orifice (FIG. 1, *B, C*); *gleba* dark brown to soot-black (FIG. 1, *A*), columella absent; *capillitium*, threads straight, apically acuminate, 1–4 mm. long, ex-

tending in compact masses of parallel hyphae inward to the center of the sporocarp, remaining lightly attached to its wall at maturity, breaking away under weathering, threads smooth, not easily fragmenting, amber-colored under the microscope, usually thinner than the spores, 4–7 microns thick, very abundant, walls thick, not pitted; *spores* globose, 5–9 microns in diameter including the verrucae, opaque (in water mountant), apiculate, with a short, hyaline apiculus (the stump of the pedicel); *epispore* dark chestnut brown, covered with coarse, subhyaline verrucae which are blunt, cog-like, up to 1.4 microns long by 1.1 microns wide, often deciduous.

Sporophora 1–3 cm. in diam., depresso-globosa; *exoperidio* albo; *endoperidio* tenuissimo, flaccido, glabro, plumbeo; *ore* ex irregulari elliptico; *gleba* atrobrunnea; *filamentis* capillitii rectis, 1–4 mm. longis, paralliter compactis, glabris, succineis, copiosis; *sporis* globosis, 5–9 microns in diam., atrocasteneis, valde verrucosis.

HABITAT: Solitary or gregarious in the vegetable debris under trees of *Juniperus monosperma.*

DISTRIBUTION: New Mexico, Lincoln County, near Corona, in the Gallinas Pinon-Juniper Forest, elevation 7100 ft. April 21, 1940, *W. H. Long & David J. Stouffer* (Nos. *8736* & *8744*). The Type collection, No. *8736,* consisting of *sixty specimens,* is deposited in the following herbaria, *50 plants* in the Long Herbarium, *5* in the University of California Herbarium at Berkeley, and *5 specimens* in the Mycological Collections of the Bureau of Plant Industry.

Bovistina is very similar in shape and peridia to *Bovista* and *Lanopila* but differs markedly in capillitial characters; *Bovistina* has a capillitium of long, unbranched, *Geaster*-like threads arising from the inner walls of the endoperidium; *Bovista* has a capillitium of discrete branched units; while *Lanopila* has long, sparingly branched, *Calvatia*-like threads, which at maturity are easily broken into short segments.

Bovistina atrogleba resembles somewhat old weathered plants of *Bovista plumbea* and could easily be mistaken for this species while collecting, however a microscopic examination of the gleba would determine its true status.

One of the most remarkable characters of this plant is the very long capillitial masses of parallel hyphae which extend into the center of the sporocarp, resembling in this respect the capillitia of

certain *Geasters*. These hyphae are agglutinated into a compact mass for about ⅔ of their length from point of attachment and are held so firmly together that the endoperidium can be peeled from the gleba leaving it a naked ball of capillitial threads and entangled spores. The agglutinating substance apparently is the disintegrated, amorphous remains of the hymenial tissues.

ACKNOWLEDGMENTS

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A NEW SPECIES OF ACHLYA FROM COSTA RICA

FRED T. WOLF

(WITH 13 FIGURES)

Within the past several years, a considerable number of soil samples from various localities have been examined by the writer for the presence of aquatic fungi. Through the kindness of Professor Rafael Lucas Rodriguez, of the Liceo de Costa Rica, a number of collections of soil from the vicinity of San José, C. R., were secured for study. The isolation of *Allomyces arbuscula* from four of these collections has already been reported elsewhere (Wolf, **1941**). In addition to *Allomyces,* there was found in two of these collections of soil from Costa Rica an interesting species of *Achlya* which is apparently not identical with any member of this genus hitherto described, and for which the following name is proposed:

Achlya Rodrigueziana sp. nov.

Growth on hemp seed rather dense, reaching a diameter of about 2–2.5 cm. Main hyphae about 40–50 μ in width at the base. Sporangia abundant, renewed by cymose branching from below. Zoöspores on discharge encysting to form a hollow sphere at the mouth of the sporangium; encysted zoöspores about 10 μ in diameter. Gemmae fairly abundant, rod-shaped, formed by segmentation of the hyphae. Plant homothallic. Oögonia spherical, abundant in older cultures, 30–50 μ, averaging 42 μ in diameter, borne on short lateral stalks from the main hyphae; wall of the oögonium smooth, hyaline, unpitted. Oöspores 1–4 in an oögonium; about 50 per cent of the oögonia with a single oöspore, 40 per cent with two oöspores, 10 per cent with 3 oöspores; four oöspores very rare. Oöspores 20–30 μ in diameter, averaging 27 μ, at maturity eccentric, with a single large oil droplet; oöspore wall smooth, thick. Antheridia almost invariably diclinous in origin, very rarely androgynous; antheridial hyphae very slender and branching. Antheridia on a majority of the oögonia, 1–3 when present, rather

long and tubular, irregularly swollen; antheridial tubes visible. Oöspores in oögonia lacking antheridia maturing parthenogenetically. Type locality; Rio Maria Aguila, San José, C. R.

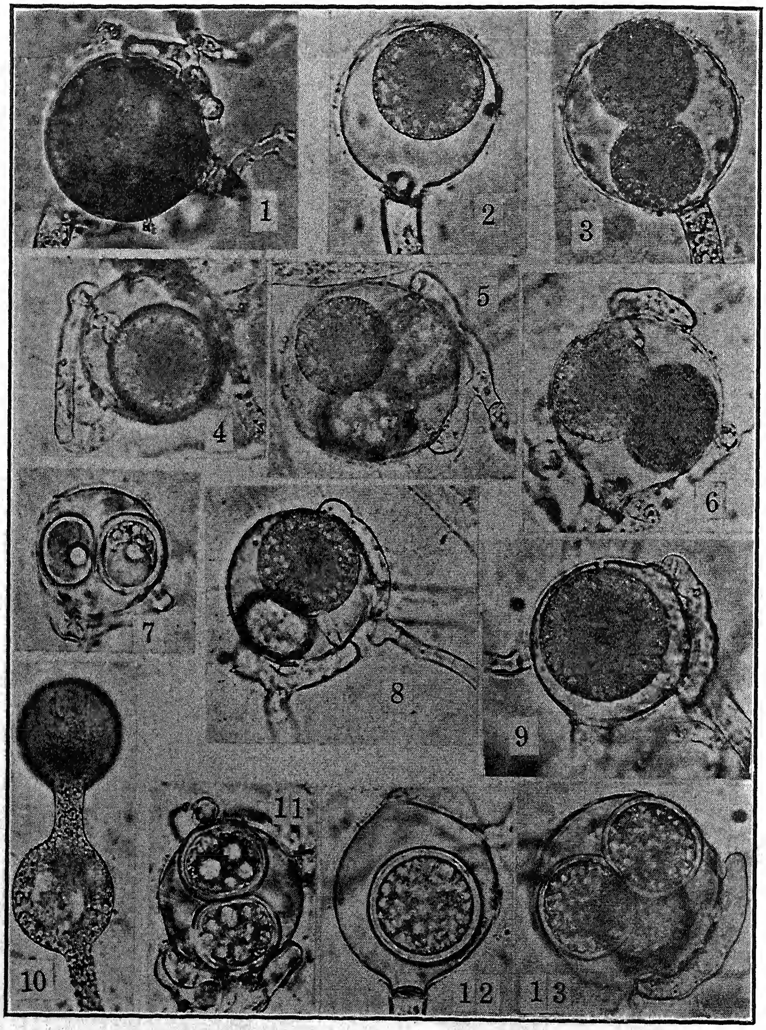
Myceliis in semine *Cannabis sativae* densis, quandoque usque 2.0–2.5 cm. lat.; hyphis primaribus basi 40–50 μ diam.; sporangiis copiosis, et e basi proliferantibus et tunc cymosis; zoosporiis apice dehiscentibus et in sphaerula dispositis; sporis hibernantibus 10 μ diam. Gemmis plus minusve copiose evolutis, cylindraceis, ex articulis hypharum efformantibus. Plantae homothallicae. Oogoniis globosis, ad ultimum numerosis, 30–50 μ plerumque 42 μ diam., in ramulis brevibus et lateralibus insidientibus; tunica oogoniorum hyalina, non-punctulata et omnio levi; oosporis 1–4 in quoque oogonio nascentibus, plerumque singulis vel binis, raro ternatis vel quaternis, 20–30 μ plerumque 27 μ diam., maturitate guttulis oleosis variae magnitudinis excentrice coadunatis; episporio levi, crasso; antheridiis praesentibus vel interdum deficientibus, origine diclinis raro androgenis, hyphis antheridiorum longis gracillibus, ramosis, tubulosis, irregulariter bullatis, 1–3 pro quoque oogonio; tubulis antheridiorum visis. Oosporis interdum parthenogeneticis. Hab. ad terram humosam, Rio Maria Aguila, San Jose, C. R.

As has been mentioned above, this organism was isolated from two separate collections of soil; the first taken from the bank of the Rio Maria Aguila, near San José, C. R., on Nov. 18, 1939, and the second from the bank of Cucubres Creek, south of Desamparados, C. R., on Jan. 20, 1940.

Preserved material of this species has been deposited in the Farlow Herbarium of Harvard University.

According to the classification of the genus *Achlya* proposed by Coker (**1923**), this new species belongs to the "Prolifera group" of the subgenus *Euachlya,* by virtue of the normal behavior of its zoöspores in forming a hollow sphere upon discharge from the zoösporangium, the eccentric nature of the mature oöspore, and the predominantly diclinous origin of the antheridia.

The consistent production of but 1 or 2 oöspores within an oögonium is one of the most distinctive features of *A. Rodriguesiana.* In regard to this character, the Costa Rican species resembles *A. Orion* and *A. apiculata,* in which the antheridia, however, are androgynous for the most part. Similarly, the form described from Czechoslovakia by Cejp (**1934**) as *A. Hähneliana* is characterized by oögonia with a single egg, and by mostly androgynous antheridia. Among other species with smooth walled oögonia and single oöspores, *A. caroliniana, A. abortiva,* and *Isoachlya unispora* lack antheridia entirely.



FIGS. 1–13. *Achlya Rodrigueziana.*

A. Rodrigueziana is obviously not identical with any of the species listed by Coker and Matthews (**1937**); the combination of such characters as the small size of the oögonia, the small number of oöspores, and the diclinous origin of the antheridia warranting its description as new. The possibility of its relationship with any of the heterothallic *Achlyas* would appear to be ruled out by the pres-

ence of an occasional androgynous antheridium. The details of the sexual organs may be seen from the accompanying photographs (FIG. 1–13).

An interesting peculiarity of *A. Rodrigueziana,* which has also been recorded in several other members of the genus, is the proliferation of a young oögonium, in the absence of antheridia, to form a second oögonium (FIG. 10). Due to the smooth hyaline nature of the oögonial wall and the fact that there are few eggs which do not entirely fill the oögonium, the antheridial tubes are easily observed. The presence of empty antheridia on certain of the older oögonia offers evidence for the presumption that fertilization probably occurs, while the eggs of other oögonia in the same culture may mature parthenogenetically, when antheridia are absent.

It is probable that this species is normally aquatic rather than terrestrial in nature, as the material from which it was isolated consisted of mud from creek banks at or near the water line, collected in a moist condition, and allowed to become air dry. Further studies using this method of collection may bring to light additional species of the water molds, as well as contribute to our meager knowledge concerning the ecology of these forms as they occur in nature.

A portion of the work herein reported was carried out during the tenure of a National Research Fellowship in Botany at Harvard University under the direction of Dr. Wm. H. Weston, Jr., to whom the writer is indebted for many helpful suggestions. The writer also wishes to express his most sincere appreciation to Mr. A. E. Prince for assistance in the preparation of the microphotographs and to Dr. F. A. Wolf for the preparation of the Latin diagnosis.

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EXPLANATION OF FIGURES

All figures are of *Achlya Rodrigueziana.* The microphotographs were taken with a Leica camera using a 12.5 × ocular and a 100 × oil immersion objective. Magnification as here reproduced, 525 ×. FIG. 1, young oögonium, surrounded by antheridial branches; 2–3, older oögonia with eggs; note absence of antheridia; 4, oögonium and egg; note antheridium and antheridial tube to the left; 5, oögonium with 3 eggs and branching antheridium; note antheridial tube below; 6, oögonium with 2 eggs; 7, oögonium with 2 mature oöspores; note eccentric oil droplets and heavy oöspore wall; 8, oögonium with 2 diclinous antheridia; note antheridial tube below; 9, oögonium with a single large egg; 10, proliferation of oögonium to form a second oögonium in the absence of antheridia; 11, oögonium with 2 nearly mature oöspores; note the numerous oil droplets in the process of coalescence; 12, oögonium with a single thick-walled immature oöspore; 13, oögonium with 3 thick-walled immature oöspores.

SOME FLORIDA NOVELTIES

W. A. MURRILL

The specimens cited in this paper were all collected in or near Gainesville and are permanently deposited in the Herbarium of the Florida Agricultural Experiment Station.

Stropharia cyanescens sp. nov.

Pileo 12 cm. lato, umbonato, fulvo, vulnerato cyanescente; sporis ellipsoideis, 13–15 × 8 μ; stipite albo, 5–7 × 1–2 cm.; annulo amplo, albo, persistente.

Hymenophore becoming cyaneous at any point, without or within, where wounded; pileus conic to convex with conic umbo, at length expanded-umbonate or slightly depressed without umbo, closely gregarious or somewhat cespitose, reaching 12 cm. broad; surface slightly viscid at first with a few scattered, white, floccose scales, becoming dry, glabrous and shining, uniformly fulvous when young, remaining fulvous on the umbo but changing to ochroleucous and cremeous in older pilei; margin even, entire, not appendiculate; context white, without odor, taste at first strongly farinaceous, at length somewhat bitter and astringent; lamellae broad, adnate, becoming ventricose, unequal, medium close to subdistant, entire to undulate, watery-white to umbrious or purplish-brown; spores ellipsoid, smooth, opaque, dark purplish-brown under the microscope, about 13–15 × 8 μ; cystidia none; stipe tapering upward, white or cremeous, fibrillose or slightly squamulose below the annulus, hollow, 5–7 × 1–2 cm.; veil ample, white, forming a superior, simple, fixed, persistent, conspicuous ring.

Type collected by W. A. Murrill on a pile of sawdust from a stable at Gainesville, Fla., April 15, 1938 (No. *F16209*). A very handsome and characteristic species having certain points in common with *S. distans* and *S. depilata*. At first sight one may be reminded of *Agaricus arvensis* unless he happens to notice the conic umbo and adnate gills.

Stropharia subumbonatescens sp. nov.

Pileo 2.5–5 cm. lato, melleo vel isabellino; sporis ellipsoideis, 11 × 6.5 μ; stipite albo, 6–10 cm. longo; annulo non persistente.

Pileus conic-convex to expanded-umbonate, gregarious, 2.5–5 cm. broad; surface smooth, glabrous, slightly viscid, uniformly melleous or isabelline, umbo conic, margin even, entire; lamellae adnate, broad, distant, uneven, soon colored by the spores, edges entire, whitish; spores ellipsoid, smooth, purplish-brown, about 11 × 6.5 μ; stipe long and slender, slightly tapering upward, smooth, subglabrous, white or pallid, 6–10 cm. long, 2–3 mm. thick; veil slight, whitish, evanescent.

Type collected by W. A. Murrill in sandy soil on a road through pines at Gainesville, Fla., February 24, 1929 (No. *F10095*). Near *S. umbonatescens* Peck.

Gymnopilus amarissimus sp. nov.

Pileo 3–4 cm. lato, ferrugineo-fulvo, carne amara; sporis ellipsoideis, 7–10 × 4–6 μ; stipite pallido, 4 cm. longo.

Pileus convex to subexpanded, not at all umbonate, gregarious or scattered, reaching 3–4 cm. broad; surface smooth, glabrous, slightly viscid, at length shining, uniformly ferruginous-fulvous, margin even, entire, inflexed when young; context thin, pale-yellow, darkening when bruised, without odor but at once exceedingly bitter; lamellae sinuate with decurrent tooth, broad, crowded, inserted, pale-yellow to ferruginous, entire; spores ellipsoid, smooth, pale ochraceous, 7–10 × 4–6 μ; cystidia none; stipe equal or tapering upward, smooth, soon glabrous, solid, whitish to cremeous, staining ferruginous where bruised, darkening with age, about 4 cm. long and 4 mm. thick; veil fibrillose, very slight, soon vanishing.

Type collected by W. A. Murrill on a dead pine trunk in a low hammock at Magnesia Springs, Alachua Co., Florida, April 12, 1938 (No. *F16206*). A very attractive species, suggesting *Hypholoma perplexum* Peck in its younger stages.

Gymnopilus praefloccosus sp. nov.

Pileo 2–3 cm. lato, aurantiaco, floccoso; lamellis adnatis; sporis ellipsoideis, 6–8 × 4–5 μ; stipite bulboso, pallido, 4 cm. longo.

Pileus convex to subexpanded, not at all umbonate, solitary, 2–3 cm. broad; surface dry, regular, orange to yellow, uniformly and

densely clothed with large conic floccose warts, which have dark, hardened points at the disk; margin incurved, even, entire; context firm, pale yellow, unchanging, odor none, taste slightly astringent; lamellae squarely adnate, many times inserted, rather narrow, crowded, entire, pallid with a yellowish tint, becoming pale ferruginous; spores ellipsoid, smooth, ferruginous, 1–2-guttulate; 6–8 $\times$ 4–5 μ; stipe slightly tapering upward from a distinctly bulbous base, fibrillose to subglabrous, nearly smooth, pallid with a cremeous tint, 4 cm. long, 7–8 mm. thick, bulb 1 cm. broad and high; veil slight but forming a very narrow, apical, yellowish, membranous, fixed, subpersistent annulus.

Type collected by W. A. Murrill on a much-decayed sweet gum log at Newnan's Lake, Alachua Co., Florida, May 1, 1938 (No. *F15620*). A very striking and beautiful species suggesting *G. Nashii* Murr. but not cespitose. The warts are 2 mm. high and the spore print fulvous. Some species of *Pholiota* are warted but none seem to fit our plant, which is a true *Gymnopilus* in spite of its slight annulus.

Inocybe alachuana sp. nov.

Pileo 2–3 cm. lato, albo, subglabro, sapore farinaceo; cystidiis 35–40 μ, sporis angulatis, 6–8 $\times$ 4–5 μ; stipite albo, circiter 2.5 cm. longo.

Pileus conic to expanded-umbonate, at times depressed and splitting with age; gregarious, 2–3 cm. broad; surface slightly viscid, subshining, subglabrous, somewhat radially rimose in old specimens, uniformly white or whitish, margin at first incurved, even, entire; context white, thin, with distinctly farinaceous odor and taste; lamellae sinuate, broad, several times inserted, crowded, entire, pallid to rosy and finally brownish-discolored; cystidia fusoid, hyaline, scanty, projecting 35–45 μ; spores angular, irregular, subovoid in outline, uniguttulate, ferruginous, 6–8 $\times$ 4–5 μ; stipe equal, smooth, glabrous, white, solid, about 2.5 $\times$ 0.3 cm.

Type collected by W. A. Murrill in moist open soil at the edge of a pond cypress swamp on the Palatka Road about twelve miles east of Gainesville, Florida, April 10, 1938 (No. *F16201*). Found in quantity in all stages of development. An attractive white species near *I. paludinella* (Peck) Sacc.

Inocybe prae-echinulata sp. nov.

Pileo 2 cm. lato, fibrilloso-squamuloso, umbrino; lamellis adnatis; sporis echinulatis, 8 $\times$ 5 μ, cystidiis 30 $\times$ 10 μ; stipite umbrino, 3 cm. longo.

Pileus conic to expanded-umbonate, gregarious, about 2 cm. broad, rarely 3 cm.; surface dry, densely fibrillose-squamulose, uniformly umbrinous, margin even, entire; context thin, pallid, taste slightly farinaceous, odor none; lamellae adnate, broad, ventricose, medium distant, inserted, pallid to brownish; edges white, entire; spores ellipsoid in outline, pale ferruginous, very echinulate, about $8 \times 5\ \mu$; cystidia abundant, subventricose, hyaline, about $30 \times 10\ \mu$; stipe subequal, solid, subglabrous, concolorous or darker, about 3 cm. long and 2–3 mm. thick.

Type collected by W. A. Murrill in low ground by the roadside east of the Flying Field at Gainesville, Florida, April 3, 1938 (No. *F16189*). The spores appear under the microscope like short miniature cockleburs.

Inocybe subeutheloides sp. nov.

Pileo 2.5 cm. lato, hispido-squamuloso, isabellino; cystidiis $60 \times 15\ \mu$, sporis ellipsoideis, glabris, $9 \times 4.5\ \mu$; stipite albo, 2.5–3 cm. longo.

Pileus convex to expanded-umbonate, at length depressed-umbonate, gregarious, 2.5 cm. broad; surface dry, finely hispid-squamulose, slightly rimose-lacerate with age, isabelline, the umbo small, conic, subfuliginous, margin at length splitting; context thin, firm, white; lamellae sinuate-adnexed, broad, ventricose, medium distant, uneven, whitish-fimbriate on the edges, pallid to ferruginous; cystidia large, hyaline, scanty, shaped like a milk bottle, about 15 μ in diameter and projecting about 60 μ; spores ellipsoid, smooth, uniguttulate, ochraceous, about $9 \times 4.5\ \mu$; stipe short, equal, subglabrous, smooth, white, 2.5–3 cm. long and 3–4 mm. thick.

Type collected by W. A. Murrill on a bank in oak-pine woods at Gainesville, Florida, February 6, 1938 (No. *F16062*). Related to *I. eutheloides* (Peck) C. H. K.

Inocybe praenodulosa sp. nov.

Pileo 5–12 mm. lato, fibrilloso-squamuloso, umbrino, carne amara et farinacea; cystidiis $75 \times 15\ \mu$, sporis papillosis, $8 \times 6\ \mu$; stipite albo, 2–3 cm. longo.

Pileus conic to expanded-umbonate, gregarious to subcespitose, 5–12 mm. broad; surface dry, fibrillose-squamulose, becoming somewhat lacerate, uniformly umbrinous; context thin, white, bitter-farinaceous; lamellae adnate, broad, crowded, inserted, en-

tire, pallid to fulvous; cystidia abundant, hyaline, subventricose above a short, slender pedicel, apex obtuse, about $75 \times 15\,\mu$; spores pale ferruginous, prominently adorned with long, obtuse papillae, about $8 \times 6\,\mu$; stipe slender, equal, smooth, pruinose, white, 2–3 cm. long and 1–1.5 mm. thick.

Type collected by W. A. Murrill in damp soil by the roadside at Hatchet Creek, east of Gainesville, Florida, April 7, 1938 (No. *F16194*). A small but well-marked species.

Inocybe subnodulosa sp. nov.

Pileo 2–2.5 cm. lato, innato-fibrilloso, pallide umbrino, cystidiis subventricosis, $60 \times 15\,\mu$, sporis angulatis-nodulosis, $6–9 \times 5–6\,\mu$; stipite bulboso, umbrino, 3 cm. longo.

Pileus conic-convex to expanded-umbonate, gregarious, 2–2.5 cm. broad; surface dry, rimose, innate-fibrillose, rather uneven, pale umbrinous, umbrinous on the prominent subconic umbo, margin usually splitting with age; context thin, white, taste somewhat mawkish, odor none; lamellae adnexed, rounded behind, rather broad, crowded, unequal, entire, pallid to discolored; cystidia subventricose with blunt apex and tapering pedicel, hyaline, abundant, about $60 \times 15\,\mu$; spores globose to ellipsoid in outline, coarsely angular-nodulose, ferruginous, $6–9 \times 5–6\,\mu$; stipe tapering upward from a prominent emarginate ovoid bulb, subconcolorous, subglabrous, about 3–4 cm. long and 2–4 mm. thick.

Type collected by W. A. Murrill on low ground under slash pines on the Palatka Road about twelve miles east of Gainesville, Florida, April 10, 1938 (No. *F16076*). Also collected by the author in mixed woods at Gainesville, December 1, 1926 (No. *F10082*). Related to *I. nodulosa* C. H. K.

Inocybe subprominens sp. nov.

Pileo 5 cm. lato, rimoso-fibrilloso, fulvo-isabellino; cystidiis magnis, sporis angulatis, $7–9 \times 4–5\,\mu$; stipite albo, 5.5 cm. longo.

Pileus conic-campanulate to expanded-umbonate, solitary, 5 cm. broad; surface dry, rimose-fibrillose, fulvous-isabelline, fulvous-castaneous on the prominent conic umbo, margin splitting with age; context thin, white, taste nutty, odor none; lamellae adnexed, broad, ventricose, rather distant, entire, pallid to brownish; cystidia large, flask-shaped, hyaline, abundant; spores angular, ferruginous, 7–9

$\times$ 4–5 μ; stipe tapering upward, smooth, flocculent above, white, 5.5 cm. long and about 6 mm. thick at the middle.

Type collected by W. A. Murrill in low ground at Gainesville, Florida, April 9, 1938 (No. *16128*). Also collected by the author under evergreen oaks at Gainesville, September 24, 25, 1932 (Nos. *10080, 10078*). Near *I. radiata* Peck and *I. prominens* C. H. K.

Naucoria collybiiformis sp. nov.

Pileo 1.5–2 cm. lato, albo, glabro, sapore grato; sporis ellipsoideis, 11–13 $\times$ 6–7 μ; stipite albo, 1.5–2 cm. longo.

Pileus convex to subexpanded, broadly umbonate, irregular, closely cespitose, 1.5–2 cm. broad; surface glabrous, uneven, not at all viscid, hygrophanous to milk-white, margin incurved when young, remaining hygrophanous for some time, repand, not striate; context thin, white, unchanging, fragrant like anise, taste mild; lamellae adnate, broad, unequal, medium distant, watery-white, entire, very slow to become discolored; spores ellipsoid, smooth, not guttulate, ferruginous under the microscope, fuscous in mass, 11–13 $\times$ 6–7 μ; cystidia none; stipe cartilaginous, hollow, subequal, soon glabrous, watery-white to white, 1.5–2 cm. long and 3–4 mm. thick; veil entirely lacking.

Type collected by W. A. Murrill in a sawdust pile at Gainesville, Florida, April 15, 1938 (No. *F16207*). Peculiar in having the appearance of a *Collybia* but showing ferruginous spores under the microscope. It is our only white species.

Tubaria subcrenulata sp. nov.

Pileo 1–2 cm. lato, roseo-isabellino, flocculoso; sporis ovoideis, 7–8 $\times$ 4–5 μ; stipite roseo-isabellino, 2.5–3 cm. longo.

Pileus convex to slightly depressed or subumbilicate, gregarious or cespitose, 1–2 cm. broad; surface dull rosy-isabelline, somewhat rugulose, finely floccose with whitish scales from the raised cuticle, plicate-sulcate with age, margin concolorous, even, entire; context very thin, without taste or odor; lamellae short-decurrent or adnate with decurrent tooth, rather distant, broad, inserted, entire, fulvous with age; spores ovoid, smooth, uniguttulate, pale ochraceous, 7–8 $\times$ 4–5 μ; cystidia none; stipe slender, very slightly enlarged upward, smooth, shining, pale rosy-isabelline, whitish-mycelioid at the base, subfibrillose to glabrous, striatulate above, cartilaginous,

2.5–3 cm. long, 1–2 mm. thick; veil forming at times a slight apical annulus.

Type collected by W. A. Murrill in humus in oak woods at Gainesville, Florida, November 12, 1932 (No. *10076*). Also collected by the author at Gainesville, Fla., November 8, 1932 (No. *10077*); and in wet soil in a low hammock, March 6, 1938 (No. *16074*). It is closely related to *T. crenulata.*

Nolanea subavellanea sp. nov.

Pileo 3.5 cm. lato, umbonato, squamuloso, avellaneo, sapore farinaceo; lamellis adnexis, sporis angulatis, 10–12 × 6 μ; stipite pallido, glabro, 5–8 cm. longo.

Pileus conic to expanded with conic umbo, slightly depressed with age, gregarious or scattered, reaching 3.5 cm. broad; surface smooth, squamulose, opaque, avellaneous, fuliginous on the umbo, margin even and entire, often splitting with age and becoming striatulate over the gills; context very thin, pallid, without odor until dried, taste strongly farinaceous; lamellae adnexed, ventricose, broad, inserted, rather distant, entire, pallid to pale pink; spores very irregular, angular, pink, 10–12 × 6 μ; stipe long, slender, smooth, glabrous, shining, hollow, very slightly tapering upward, pallid with a faint yellowish tint, twisted at times, finely striatulate, whitish-mycelioid at the base, 5–8 cm. long, 2.5–5 cm. thick.

Type collected by W. A. Murrill in soil in a low hammock near Gainesville, Florida, March 5, 1938 (No. *F16075*). Also collected twice in woods at Gainesville by E. West and W. A. Murrill on November 8, 1932 (Nos. *F10016, F10022*). Suggesting my *N. avellanea* but squamulose. After drying in the sun a strong, persistent, rancid odor developed.

Russula subpusilla sp. nov.

Pileo convexo ad depresso, 3–4 cm. lato, glabro, roseo vel roseo-cremeo; carne alba, grata; sporis subglobosis, flavis, echinulatis, 6–8 μ; stipite albo, 3–5 × 1 cm.

Pileus convex to depressed, solitary or gregarious, 3–4 cm. broad; surface slightly viscid when moist, smooth, glabrous, roseous or roseous-cremeous, cuticle separable, margin scarcely striate; context white, unchanging, sweet or very slightly astringent; lamellae white to yellow, adnexed, narrow, close, entire, equal, very few

forking; spores subglobose, distinctly echinulate, yellow, 6–8 μ; cystidia none; stipe equal, white, smooth, glabrous, about 3–5 × 1 cm.

Type collected by George F. Weber on the ground under an oak at Gainesville, Fla., July 1, 1926 (*F9512*). Also collected by West & Murrill in oak woods at Gainesville, Nov. 9, 1932 (*F9554*); and by W. A. Murrill on a lawn under an oak in Gainesville, May 10, 1938 (*F9522*). *Russula pusilla* Peck is red, not pink, and grows under pines rather than oaks.

Lepiota floridana sp. nov.

Pileo convexo, 3–5 cm. lato, squamuloso, cremeo, disco castaneo; sporis 6 × 5 μ; stipite albo, castanescente, 4–5 cm. longo, abrupte bulboso; annulo amplo, medio.

Pileus convex to subexpanded, not umbonate, gregarious, 3–5 cm. broad; surface dry, squamulose, white with cremeous scales, the disk castaneous; margin white, short-striate and almost free of scales in older hymenophores; context firm, white, unchanging, sweet and nutty; lamellae free, remote, rounded behind, narrow, crowded, a few forked and a few inserted, entire, white, unchanged on drying except near the stipe; spores subglobose to broadly ellipsoid, smooth, hyaline, about 6 × 5 μ; cystidia none; stipe tapering upward, smooth, glabrous, white, becoming partly or wholly castaneous on drying, 4–5 × 0.4–0.8 cm.; bulb abrupt, large, about 1.5 × 1.3 cm.; annulus ample, membranous, median, fixed, persistent, single, white above and castaneous below.

Type collected by W. A. Murrill in rich, exposed, grassy soil in Gainesville, Fla., May 13, 1938 (No. *F16250*). The abrupt bulb suggests *L. abruptibulba* Murr., described from Cuba. The stipe assumes on drying the color found on the disk of fresh plants.

Venenarius subvirginianus sp. nov.

Pileo 2 cm. lato, glabro, avellaneo, striato; sporis 10–12 × 8–9 μ, cystidiis clavatis, obtusis, 20 μ; stipite albo, 4 cm. longo; annulo parvo, volva cupuliformi, parva, alba.

Pileus convex to plane, not umbonate, solitary, 2 cm. broad; surface somewhat viscid, glabrous, without volval patches, uniformly avellaneous, margin entire, concolorous, conspicuously striate halfway to the center; context very thin, white, without odor; lamellae adnexed, of medium width and distance, not forked, twice inserted,

slightly ventricose, entire, white; spores subglobose or broadly ellipsoid, smooth, hyaline, uniguttulate, 10–12 × 8–9 μ; cystidia large, clavate, inflated, obtuse, thin-walled, hyaline, scanty, projecting about 20 μ; stipe very slightly tapering upward from a small bulb, dry, smooth, minutely pubescent under a lens, milk-white, unchanging, 4 cm. long, 3.5–4 mm. thick; annulus median, fixed, small, simple, persistent, white; volva narrow, lobed, the limb free, white.

Type collected by W. A. Murrill on moist black soil in a low hammock near Gainesville, Florida, March 27, 1938 (No. *F16134*). Suggesting *V. virginianus* but differing in color and in certain other characteristics. The cystidia nestle among the basidia like laterally compressed balloons.

NEW COMBINATIONS

For those using Saccardo's nomenclature the following new combinations are made:

Gymnopilus amarissimus = **Flammula amarissima**
Gymnopilus praefloccosus = **Flammula praefloccosa**
Venenarius subvirginianus = **Amanita subvirginiana**

GAINESVILLE, FLORIDA

OBSERVATIONS ON MINDENIELLA SPINOSPORA [1]

F. K. Sparrow, Jr., and V. M. Cutter, Jr.

(with 1 figure)

In 1927, Dr. B. B. Kanouse (1) reported the finding on submerged rosaceous fruits in the vicinity of Ann Arbor, Michigan, of an extremely interesting aquatic Phycomycete, which she described as *Mindeniella spinospora,* a new genus and species of the Blastocladiales. Since then, if one may judge from reports in the literature, the fungus has apparently remained unobserved.

In general habit it closely resembled a species of *Blastocladia,* particularly those forms of *B. Pringsheimii* in which the apex of the basal cell is unbranched and strongly expanded. Furthermore, like *Blastocladia,* it occurred in pustules on the substrate, mixed with other water molds such as *Rhipidium* and *Gonapodya.* It was pointed out at the time, however, by Dr. Kanouse, that her fungus differed markedly from other blastocladiaceous organisms in the following respects: the strong cellulose reaction of the walls, the reproductive organs being borne on short pedicels, and in the formation of delicate spines on the resting spores and on certain sporangia. As has been previously pointed out by the senior author (2), the precise relationships of Dr. Kanouse's fungus—combining as it did certain characteristics of both Blastocladiales and Leptomitales—could not be ascertained until studies were made of the structure and flagellation of the zoöspores. This was essential, since it is now recognized that among water fungi as among other members of the plant kingdom, parallelisms of body form frequently occur among species of very different orders, which often obscure their true relationships. It was also suggested at the time that *Mindeniella* showed strong affinities with *Araiospora,* a member of the Leptomitales, and indeed, that if the zoöspores were

[1] Paper from Department of Botany, University of Michigan, No. *771,* and Department of Botany, Cornell University.

found to be laterally biflagellate, there were strong reasons for including it in this genus. On the other hand, if the zoöspores possessed a single flagellum, the inclusion of *Mindeniella* in the Blastocladiales as done by Kanouse, was fully justified. It was evident, then, that the affinities of the fungus depended upon the structure of the zoöspore.

As Dr. Kanouse suggests in her paper, *Mindeniella* is evidently of rare occurrence. Indeed, although the senior author has examined many hundreds of submerged rosaceous fruits from American and European sites in the past decade, he has never heretofore encountered it. During the summer of 1940 the authors were fortunate in obtaining large quantities of *Mindeniella* from a small pool in the courtyard of the Natural Science Building in Ann Arbor, which enabled them to make such a study of the organism as would throw definite light on its precise affinities and relationships to the other water molds. Since the pool in question had long acted as a general dumping ground for various aquatic plants and animals collected in the vicinity of Ann Arbor, the exact place of origin of the fungus was not known. Dr. Kanouse assures us, however, that at no time was her material collected from this pool nor was any *Mindeniella* ever put in it by her. In view of its apparent rarity it is interesting to note that the substrata in our collections were frequently covered with pustules composed, so far as filamentous fungi were concerned, of nothing but *Mindeniella*. It would appear therefore, that, although the fungus may be rather local in its distribution, it may be abundant where it does occur.

The thallus of the plant (FIG. *D*) resembles *B. Pringsheimii,* consisting of a well-developed basal cell which is anchored in the substrate by a system of branched hold-fasts. The basal cell is predominantly narrowly clavate, rarely cylindrical. In a few cases it may be divided at the apex into two blunt lobes, but nothing approximating the pronounced diverticula found, for example, in certain thalli of *Blastocladia Pringsheimii,* is formed by *Mindeniella*. The basal cell may attain a length of 850 μ, although in most cases it is not over 500 μ. Its narrow, proximal part from which the branching, blunt-tipped hold-fast system emerges, is seldom over 30–40 μ in diameter, whereas the usually expanded and rounded dome-like apex may be 200 μ wide. The colorless wall is stout and

on the outer surface of older plants there may frequently be found bits of exfoliated material. A strong cellulose reaction is apparent when chlor-iodide of zinc solution is applied.

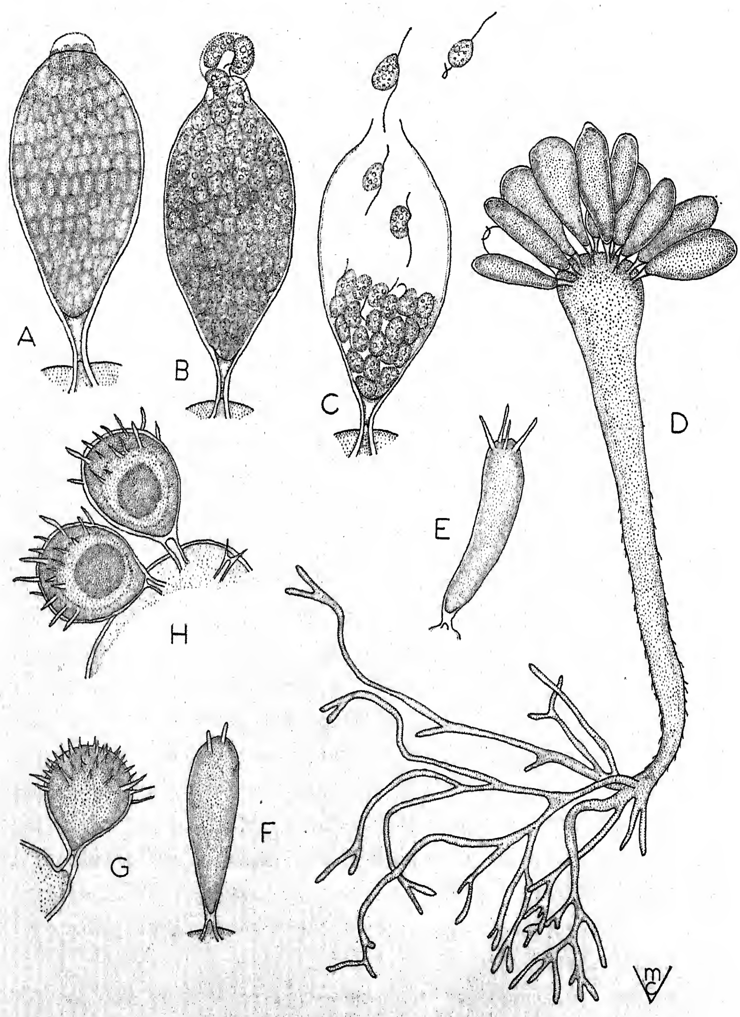

FIG. 1. *Mindeniella spinospora.*

Zoösporangia are formed for the most part over the surface of the dome-like, expanded, distal part of the basal cell. In certain plants, particularly those in old pustules, they may also arise lower

down on the trunk. As in *Rhipidium* and *Araiospora,* the zoösporangia, which may be 1–12 or more in number, are borne on short, narrow thick-walled pedicels, here, however, arising directly from the basal cell. They are usually narrowly and symmetrically clavate or ovate (FIG. *A*), and occasionally slightly constricted in the mid-region. At maturity a prominent apical discharge papilla is formed. The sporangia are somewhat variable in size, fully mature specimens varying from $125 \times 33\,\mu$ to $250\,\mu$ long by $50\,\mu$ in greatest diameter. A peculiar feature of *Mindeniella,* found also in the genus *Araiospora,* is the formation of two types of sporangia —spiny and smooth-walled. In contrast to most species of *Araiospora,* however, no differences in shape or size are apparent between sporangia of the two types. The spiny sporangia bear 1–8 erect spines which are irregularly disposed around the discharge papilla (FIGS. *E, F*), whereas, of course these are lacking in the more common smooth-walled type.

The zoöspores are fully formed within the sporangia. At the moment of discharge the apical papilla suddenly expands to form a delicate vesicle which surrounds the first of the emerging zoöspores (FIGS. *A–C*). This structure soon disappears, however, after which the great majority of swarmers emerge individually at a rapid rate. They swim away at once from the vicinity of the sporangial orifice. The zoöspore (FIG. *C*) is of the "secondary" type, commonly described as "reniform," "bean-shaped," or "grape-seed-like." It is $8–15\,\mu$ long by $6–10\,\mu$ wide, the majority being about $8 \times 12\,\mu$. The contents are characterized by the possession of numerous small refractive globules which lend to the spore an appearance strikingly similar to that exhibited by the zoöspores of *Rhipidium.* A slightly anteriorly disposed vacuole is also usually found. There are two oppositely directed flagella. Definite evidence for at least one repeated emergence of the zoöspore was observed.

A few, probably immature, resting spores were found, but, in spite of intensive and prolonged search, not in sufficient numbers to add anything new to the account of these structures already given by Kanouse. In our material they occurred on thalli with the zoösporangia, each being formed in a nearly spherical container, $56–59\,\mu$ in diameter, with a thickened wall. The upper ⅓

to ½ of the outer surface of the container bore numerous slender, very sharp-pointed, colorless, solid spines, 15–25 μ in length. In the dense contents of the spore itself, there could be observed a large central, brownish oil globule. Whether or not the material between the periphery of the globule and the inner wall of spiny container was cytoplasm or wall material could not be determined. During the latter part of the summer numerous empty spiny containers were found (FIG. *G*). No fracturing of the wall could be detected and the method whereby the resting spores had slipped from their case—if such an interpretation is justified—is not known.

No antheridial structures were found and, as Kanouse pointed out, the spore is apogamously developed.

DISCUSSION

Mindeniella spinospora is unquestionably distinct among the aquatic Phycomycetes and well merits the generic individuality given it by Kanouse. While in general habit and mode of life it resembles *Blastocladia,* its pedicellate reproductive organs, cellulose walls, and particularly its biflagellate zoöspores, show it to belong to the Leptomitales. Of the members of this order, *Mindeniella* in one or another characteristic, shows distinct affinities with two genera, *Rhipidium* and *Araiospora.* In *Rhipidium* the basal cell is similar to that of *Mindeniella,* but strongly expanded distally to form a platform from which hyphal branches or less commonly, the pedicellate zoösporangia arise. The zoöspores of *Rhipidium* bear refractive globules and are formed in sporangia similar in shape but shorter than those of *Mindeniella.* In *Araiospora,* while the basal cell is more cylindrical, two types of zoösporangia are formed, one smooth, the other, as in *Mindeniella,* ornamented with sharp spines. *Mindeniella* differs from both of these genera, however, in the lack of branches arising from the basal cell, in the lack of sexual reproduction, and in the formation of an apogamous resting spore borne in a spiny container.

There can, therefore, be no further doubt that *Mindeniella spinospora* belongs in the Leptomitales rather than in the Blasto-

cladiales, where, because of the remarkable similarity in body form, it was placed by its discoverer.

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EXPLANATION OF FIGURES

FIG. 1. All figures were drawn with the aid of the camera lucida from living material. Fig. *D* × 280, all others × 600. Figures drawn by V. M. Cutter, Jr. *A*. Nearly mature sporangium showing basal pedicel and apical discharge papilla. *B*. Initiation of zoöspore discharge. The first emerged zoöspores are surrounded by a delicate quickly evanescent vesicle. *C*. Later stage in discharge. The zoöspores are emerging individually. *D*. Complete plant showing hold-fast system and clavate basal cell on the apex of which the zoösporangia are borne. *E, F*. Spiny zoösporangia. *G*. Empty, spiny container of resting spore. *H*. Two immature resting spores in their spiny containers. Each bears a large brownish globule in its contents.

NOTES ON THE MYCETOZOA—V

Robert Hagelstein

In this paper, I continue the practice of reporting annually the interesting specimens of Mycetozoa added during the year to the collection in the Herbarium of the New York Botanical Garden. Prior to the publication of this series of Notes, the records of the distribution in North America were deficient in many species. Many were said to be rare, or more exactly, rarely collected. The Notes have shown that many species formerly regarded as rare are not uncommon, and are well distributed geographically. The results are due to the efforts of experienced collectors, who take into consideration the habitat, the time of appearance, and the local natural conditions applying to the area of their collecting activities.

Much depends upon the seasons for the prolific development of the fruiting bodies. In the tropics, where there is no alternation of winters and summers, they are not so abundant. In lowlands of the temperate zones, like Long Island where I reside, the winters are often open with little snow and frequent periods of warm weather. During such warm spells, if continued, the plasmodium revives, vegetates, and produces fruit, the latter while forming often meeting sudden changes to freezing temperatures, which destroy it so that it is incapable of further reproduction of the species. The best conditions are found in mountainous regions at higher altitudes, or in other territory where the winters are continuous. Here the sclerotium does not revive until the spring, and the resulting fruit does not meet the additional hazards of the winter fruitings. Subject to the local conditions of moisture and food supply, it will be found that following a cold, closed winter there will be an abundant crop of fruiting bodies at some time during the season, depending more or less on the local weather conditions. At such times the less often collected species may be looked for.

We were unable to attend the Foray of the Mycological Society of America held in Maine, in August. Our entire time was therefore devoted to Pike County, Pennsylvania, which was kept under

close observation from late in May to the middle of October by frequent visits of long or short duration. The winter conditions had been as outlined, and the abundant crops appeared in July and October, although large developments were found as early as the end of May. As was expected, many unusual species were found, and five of them for the first time in our collecting experience. There were disappointments and thrills in between, and the greatest thrill came in October when the log later described under *Colloderma oculatum* was found. In addition to the species noted there were four others, *Diderma radiatum* (L.) Morg., *Licea flexuosa* Pers., *Trichia Botrytis* (Gmel.) Pers., and *Trichia decipiens* (Pers.) Macbr., a total of eight on one log, and all in a state of perfect maturity. A few feet away, on another log, was a development of *Cribraria rufa* (Roth) Rost.

Many interesting species are found on dead, coniferous wood such as pine, hemlock, spruce, etc. The best logs are the larger ones, a foot or more in diameter, and they should be in the state of decay with lichens and liverworts growing on them. Mosses are also present usually, and they conceal many sporangia so that careful search should be made. When a good form is found, the area should be worked thoroughly for logs with other developments, as the Mycetozoa have the habit of appearing in many fruitings at the same time. Plenty of material should be taken as the form may not be found again for years. Undoubtedly the same species will appear again, but it may be in another place, and the collector cannot cover everything. It is surprising how little area is actually covered in a season. Taken together, foot by foot, it amounts to only a few acres.

The species of *Amaurochaete* and *Brefeldia* must be rare in eastern North America. We have found *A. fuliginosa* (Sow.) Macbr. and *B. maxima* (Fries) Rost. on Long Island, but not elsewhere, and they have not come here from other students in recent years. Ontario, with its ardent students who have uncovered so many good things, may bring them forth again.

Collections herein reported were all in the year 1940 unless otherwise stated. When no collector's name is given, they were made by Joseph H. Rispaud, John D. Thomas, or me, or working in company.

ARCYRIA FERRUGINEA Sauter. A beautiful example of the large phase with spores under 10 μ diam. was received from Roy F. Cain of the University of Toronto, and collected by W. R. Watson at Lake Timagami, Ontario, in September 1923. It seems to be rare compared with the small phase having larger spores which we found eight times during the season in Pike County, Pennsylvania, and on many occasions previously. Four specimens of the small phase have also come here collected by Eli Davis or W. D. Sutton in different areas of Ontario on different days. Both write that it was not uncommon during the season. The spores in the latter are slightly below 10 μ diam. Comparing extremes of the two phases, it might appear that they are separate species, but the material now available here with intermediates justifies the belief that all should be regarded as *A. ferruginea.* N. Y. B. G. Nos. *9426, 9554, 9555, 9556, 9557.*

ARCYRIA STIPATA (Schw.) List. A fine collection made in Pike County, Pennsylvania, in September, is notable for the distinctness of the spirals on the capillitium. The spirals are not, however, like those of a *Hemitrichia* where they are continuous ridges or thickenings which wind around so that they can be seen on the edges and their number counted. In our specimen the threads of the capillitium are ornamented with warts or spines and short protuberances arranged diagonally across the threads, and it is the intervals between them that appear in the microscope like continuous windings.

Hemitrichia imperialis G. List. (Trans. Brit. Myc. Soc. **14**: 225–227. 1929) is very much like *A. stipata,* but has true spirals like a *Hemitrichia.* N. Y. B. G. No. *2765.*

COLLODERMA OCULATUM (Lipp.) G. List. In early October, Mr. Rispaud and Mr. Thomas entered a small, swampy area in Pike County, Pennsylvania, which had not been visited before. Observing a large coniferous log, thickly covered with mosses, lichens, and liverworts, they examined it and found thereon a number of species of Mycetozoa including *Lepidoderma tigrinum* (Schrad.) Rost., *Diderma roanense* (Rex) Macbr., and *Lamproderma columbinum* (Pers.) Rost. On their return in the evening, and while studying the various species from this log under the

microscope, we were surprised to find among them many single, widely separated sporangia of *Colloderma oculatum.* These had formed during the day on the wet base, and were surrounded at the lower part by the gelatinous sheath characteristic of the species. The emerged sporangia were more often of a dull, dark blue color, although occasionally iridescent blue or purplish-brown.

A week later I joined my friends in another visit to the locality, and we took back with us the remaining moss from the log, which gave us abundant material, although as the sporangia are widely separated and often covered by moss, it is difficult to select them. On another log nearby, we found another small development, and in other parts of the area several unusual species were discovered.

The capillitium in the sporangia of *C. oculatum* consists of a persistent, netted mass of hyaline threads attached to the base of the sporangium. The threads are broader below, becoming slender at the tops, and many of them are jointed or segmented. The spores are purplish-gray, distinctly spinulose, and measure about 12 μ diam. N. Y. B. G. Nos. *2627, 2741.*

COMATRICHA CORNEA G. List. & Cran. Mr. Brooks has sent here two different specimens of a minute *Comatricha* which developed in a moist chamber on wetted wood collected in Geary County, Kansas. They agree in nearly all respects with the description of *Comatricha cornea,* particularly in the character of the translucent stalks which are reddish-brown throughout the greater part of their length, darker at the tops, and yellowish-brown at the bases. They are striated longitudinally, indicating a fibrous structure. The sporangia are small 0.1 to 0.2 mm. diam., and the stalks are 0.3 to 0.5 mm. in length, much longer than described by the authors of the species. The columella and capillitium meet the description even to the small collar at the base of the sporangium. The spores are violet-gray, 8.5–9.5 μ diam., and are marked with spines that can be seen distinctly on the edges, with some of the spores larger and darker than the others.

The species is unknown from North America so far as I know. The translucent, fibrous stalk is the important feature and characteristic. The length of the stalks is unimportant in my opinion, as in nearly all Comatrichas we find great variation in the length of

the stalks. Likewise with the stronger marking of the spores. These forms are probably *C. cornea,* and are so regarded. N. Y. B. G. Nos. *9305, 9341.*

COMATRICHA ELEGANS (Racib.) List. One of my associates, Leon J. Chabot, is very active in the collection of the Mycetozoa while on trips in his automobile throughout Nassau County, New York. On one of the last days in May he found a small fruiting of *C. elegans,* which on closer examination at home was seen to have orange-red spores in mass and also under the lens. This is var. *pallens* G. List. proposed in the 3rd edition of the British Monograph for a phase with reddish-lilac spores, only, in our specimen, the reddish tints are more strongly emphasized. The reddish spores are in the fresh sporangia where the spores are still intact. In the older sporangia where almost all the spores are dispelled, the few remaining have changed in color to the brownish-violet tints of the normal form. There is nothing to indicate that the development is abnormal although it formed in a long period of rain. Differences in spore colors are known in many species. I doubt the spore color in var. *pallens* is important enough to regard it as a constant, definite variety, believing it is caused by adverse conditions prevailing at the time of development. N. Y. B. G. No. *2054.*

COMATRICHA NIGRA (Pers.) Schroet. A collection made in Pike County, Pennsylvania, in September, has ellipsoid sporangia 1 mm. in the larger diameter, on long thin stalks, with a total height of 8 mm., an extraordinary size for this species. N. Y. B. G. No. *2720.*

COMATRICHA RISPAUDII Hagelstein. Found on five occasions in different areas of Pike County, Pennsylvania, in August. N. Y. B. G. Nos. *2716, 2717, 2718, 2719, 2806.*

COMATRICHA RUBENS List. Strange, that this species has such a narrow range of distribution in the American literature. It should be found almost anywhere on leaves if carefully searched for as it is not rare. Specimens are in the Herbarium of the New York Botanical Garden from Maine, Massachusetts, New York, Pennsylvania, Virginia, and Quebec.

CRIBRARIA CUPREA Morg. The species has come here collected by Mr. Eli Davis at Komoka, Ontario, in June. It was also found by Mr. Travis E. Brooks in Geary County, Kansas, in July 1937. There seem to be reasons for regarding it as distinct from *Cribraria languescens* Rex, aside from the copper color which has been over emphasized, and is not always pronounced. Color in all the Cribrarias is an uncertain character. In the calyculus and nodes, it depends somewhat upon the abundance of the dark, plasmodic granules. In the spores, the color changes with age. *C. cuprea* is much smaller than *C. languescens;* the stalks are firmer; the cup is not so cleanly defined; the net is more irregular; and the nodes are thinner and more flattened. In some of these characters the form will approach *C. languescens* at times, but intermediate forms are common in nearly all Cribrarias. N. Y. B. G. Nos. *8327, 9558.*

CRIBRARIA LANGUESCENS Rex. The species is not reported often from eastern North America, and we have never collected it until this past season, when two gatherings were made in Pike County, Pennsylvania, in August. A similar collection was also made by Mr. Eli Davis at Byron, Ontario, in June. Altogether it is a fine form developing on dryer and firmer wood, and not so scraggy as many of the other Cribrarias. N. Y. B. G. Nos. *2710, 2808, 9559, 9560.*

CRIBRARIA LAXA Hagelstein. Found on two occasions in Pike County, Pennsylvania, in August. Each time a development of *Comatricha Rispaudii* Hagelstein was nearby, and the same association has been noted with earlier collections. Both forms should be searched for on leaves in dryer portions of wet swamps. N. Y. B. G. Nos. *2794, 2802.*

CRIBRARIA RUFA (Roth) Rost. Pike County, Pennsylvania, furnishes another record for this species where it was found in October on the under side of a rotting log. The specimen is nowhere as handsome as others from the western States, or from Europe, but normal and well matured. The orange color, with the wide meshed net and hardly expanded nodes, are characteristic. A similar collection was made by Mr. Eli Davis at Komoka, Ontario, in September. N. Y. B. G. Nos. *2742, 9561.*

CRIBRARIA SPLENDENS (Schrad.) Pers. Found in Pike County, Pennsylvania, in September. The species apparently forms small plasmodia with subsequent few sporangia, and in very wet areas. That has been the case with all our collections. N. Y. B. G. No. *2798*.

DIACHEA BULBILLOSA (Berk. & Br.) List. In addition to earlier records (Mycologia **30**: 341–342. 1938) the species has been found at various times in Indiana, Kansas, North Carolina, and Ontario, as represented by specimens here. N. Y. B. G. Nos. *2872, 8598, 8790, 9363, 9364, 9578*.

DIACHEA CAESPITOSA (Sturg.) List. The species resembles *Diachea cylindrica* Bilgr., and is closely related but has different spores. In *D. cylindrica* they are reticulated with spines. In *D. caespitosa* they have prominent warts. A typical example was collected by Mr. Eli Davis at Byron, Ontario, in August, on the tips of spagnum moss. Mr. Davis writes that the plasmodium observed was orange-yellow when commencing to fruit. N. Y. B. G. No. *9562*.

DIACHEA MIYAZAKIENSIS Emoto. The first North American collections, made by Mr. Eli Davis in Ontario, were reported by Dr. John Dearness in Mycologia **32**: 265. 1940. The species was found again by Mr. Davis at Komoka, Ontario, in August. Mr. Davis writes that he believes the three collections made during 1939 and 1940 were on black ash, although the wood was too far gone to permit positive identification. N. Y. B. G. No. *9363*.

DIACHEA SPLENDENS Peck. Beautiful examples of the species have come here from Mr. Travis E. Brooks collected in Riley County, Kansas, in September. In addition to earlier records (Mycologia **30**: 340. 1938) it is also here from Massachusetts and Ohio. N. Y. B. G. Nos. *9580, 9581, 12569, 12571*.

DIACHEA SUBSESSILIS Peck. The species is well distributed in North America, and may be looked for almost anywhere in wooded regions. It fruits on leaves, forms small colonies, and may be distinguished from other globose Diacheas by the spores which have the warts arranged in reticulate fashion. In the Herbarium of the New York Botanical Garden there are more than 25 speci-

mens from Colorado, Connecticut, Florida, Kansas, Massachusetts, New York, Pennsylvania, Ontario, and Quebec. It is not rare.

DIANEMA CORTICATUM List. Collected by Mr. Eli Davis at Komoka, Ontario, in September. We have also found it on different occasions in past years in Pike County, Pennsylvania. The eastern collections have little or no capillitium, but may be distinguished from *Licea flexuosa* Pers., with which it is often associated, by the brown, translucent walls and clustered spores. N. Y. B. G. No. *9567*.

DIDERMA OCHRACEUM Hoffm. In September we visited the small, wet swamp in Pike County, Pennsylvania, where three years ago, in the same month, we had found many developments of *Fuligo muscorum* Alb. & Schw. Nothing was seen of that species, but instead, we found on careful search of the ground mosses a few small fruitings of *D. ochraceum*. Each of these had less than a dozen finely matured and typical sporangia, clustered somewhat on the tips of moss. The angular lime-granules are prominent in many of the sporangia. The capillitium is purplish-brown, and the spores are purple-gray, distinctly spinulose, and measure 9–10 μ diam. The species has been rarely reported from North America. N. Y. B. G. No. *2704*.

DIDERMA ROANENSE (Rex) Macbr. A small, typical development with flattened sporangia on black stalks was found on a mossy log in Pike County, Pennsylvania, in October. The black stalks separate the species from *Diderma radiatum* (L.) Morg. when the sporangia and columellae are more rounded like in the latter species. A collection was also made by Dr. Roy F. Cain at Kearney Lake, Algonquin Park, Ontario, in September 1939. N. Y. B. G. Nos. *2702, 9424*.

DIDERMA SPUMARIOIDES Fries. Several of the Mycetozoa show marked differences in the fruit of the early spring as compared with that of the later summer. The May and June fruitings of *D. spumarioides* have usually more rounded and even sporangia with smoother, thinner walls. They are more scattered and with little or no hypothallus. In August and September, the massive forms develop. The sporangia are rough, closer together, and

with thick walls embedded in a heavy hypothallus. It has been noted by other authors that lime is occasionally present in the capillitium. A collection made in Pike County, Pennsylvania, in June, has numerous, long, fusiform lime-knots like a *Physarum*. A specimen collected by Dr. W. C. Sturgis in Colorado, in September 1912, has similar lime-knots, and others found by him have long, thin, flattened or cylindrical columellae, which are often bifurcate, and extend to the tops of the high sporangia. N. Y. B. G. Nos. *2807, 7168, 13203, 13204*.

DIDYMIUM COMPLANATUM (Batsch) Rost. A specimen was found by Mr. W. D. Sutton in Sevier County, Tennessee, in August 1939, during the Foray of the Mycological Society of America. It is in the form of a very thin, effused plasmodiocarp with little capillitium. The yellow vesicles are present and characteristic of the species. N. Y. B. G. No. *9564*.

DIDYMIUM LISTERI Massee. The conceptions of *Didymium dubium* Rost. and *D. Wilczekii* Meylan as expressed in the 3rd edition of the Lister Monograph were altered by Miss Lister (Jour. Bot. **45**: 226–227. 1926) so that the former *D. dubium* is now regarded as *D. Listeri* Massee, and the former *D. Wilczekii* as *D. dubium* Rost. These conclusions have been generally accepted. *D. Listeri* is a lowland species, and *D. dubium* occurs in mountainous regions. Either one has been rarely reported from North America.

D. Listeri often forms thin, effused plasmodiocarps with a closely combined layer of crystals on a thin, membranous wall, and a sprinkling of stellate crystals on the surface. The spores are purple-gray, and generally not larger than 11 μ diam. *D. dubium* is much more robust with pulvinate plasmodiocarps and heavier lime deposits, sometimes like in certain species of *Lepidoderma*. The spores are generally more than 11 μ diam., and purple-brown. In both species the threads of the capillitium are more or less connected by transverse bars in addition to forking and branching. An examination of a dozen authentic English and Swiss specimens in the Herbarium of the New York Botanical Garden shows considerable variation in the characters, even to the spores, and a

particular character of one species may be present in a development of the other, or absent entirely.

Mr. Travis E. Brooks has sent here three specimens collected in Geary and Riley Counties, Kansas, in June and August, which are practically alike, and which I regard as the present species, rather than *D. dubium*. The fructifications are in thin, effused plasmodiocarps, sometimes branching or net-like. The compact wall of lime crystals is not present, and the stellate crystals are distributed directly on the inner membranous wall. The capillitium has the transverse bars. The spores are purple-gray, 9.5–11 μ diam. An English specimen of *D. Listeri* shows plasmodiocarps with scanty lime and others without any, and is very much like the Kansas specimens.

There are a number of species of *Didymium* that occasionally form plasmodiocarps in outward appearance like the Kansas gatherings. They are met with frequently, and some of them are not clearly determinate. The majority are *D. squamulosum* (Alb. & Schw.) Fries with purple-brown spores. Others with purple-gray spores are nearer *D. anellus* Morg. In these species the threads of the capillitium are not connected by bars. N. Y. B. G. Nos. *9373, 9376, 9377*.

DIDYMIUM OCHROIDEUM G. List. The species was found four times by Mr. Travis E. Brooks in Geary and Riley Counties, Kansas, in August. One of the developments is perfectly typical. The others are more or less paler in color, with the sporangia more pulvinate, and spores 7–9 μ diam. Mr. Eli Davis also found the species fruiting in June on manure in a greenhouse at Byron, Ontario. He sends two specimens taken a week apart. The earlier collection has ochraceous-yellow plasmodiocarps with pale, slightly grayish spores 8.5 μ diam. In the later specimen the plasmodiocarps are almost white, and the spores are pale but distinctly brownish. They measure 8.5–9.5 μ diam. These irregularities have been noted before in earlier collections. N. Y. B. G. Nos. *9378, 9379, 9380, 9381, 9565, 9566.*

DIDYMIUM PARIETALE Martin & Brooks, Trans. Am. Micr. Soc. **57**: 319–321. 1938. Mr. Brooks, the junior author, has kindly furnished me with additional collections made in Geary and Riley

Counties, Kansas, in June and August, which are practically identical with the earlier collections made each season since 1937. The interesting combination of characters, including the vesicular bodies among the spores, seems to be constant, and makes this a sharply differentiated species. N. Y. B. G. Nos. *9382, 9383, 9384.*

FULIGO SEPTICA (L.) Weber. In my Notes Series I (Mycologia **29**: 398–400. 1937), I described aethalia of this species found in great numbers at Middleburg, New York, and evidently from single plasmodia which had divided at the time of fructification. We have not found similar forms again. Prior to date of publication, I sent specimens to Prof. G. W. Martin, at Iowa City, Iowa, and he wrote to me that he regarded them as splendid examples of *Fuligo intermedia* Macbr., remarking at the same time that the original description of the latter was faulty. *F. intermedia* was described in part, as having a thin, fragile, grayish or brownish, non-calcareous cortex, and pale purple spores, gray or violaceous-gray in mass. In those respects the description does not agree with the Middleburg specimens. The description of Macbride has led to uncertainty as to what was meant by *F. intermedia.* The Listers have regarded it as *F. cinerea* (Schw.) Morg. var. *ecorticata,* but it does not seem to fit there. I have tried to reconcile it with small aethalia of *F. septica* having a thin brownish, non-calcareous cortex—and these are common enough—but not satisfactorily. There are so many phases of *F. septica,* and the aethalia in forming are so susceptive to outside influences, that these influences must be considered when regarding any development as separated specifically from *F. septica.*

During August and September, Mr. Travis E. Brooks and Mrs. Brooks found in Edwards and Riley Counties, Kansas, developments that are practically identical with those we collected at Middleburg, even to the double walls in many of the outside sporangia. Mr. Brooks writes he found them abundantly on a group of cottonwood logs, also on elm, in the vicinity of Manhattan, Kansas, with similar variations observed in our material. Here again the indications are there were large plasmodia, and large plasmodia are characteristic of *F. septica.*

I believe Macbride's description was intended to cover forms like those mentioned, and it may be convenient to accept them as *F. intermedia* if the description can be altered satisfactorily. Nevertheless, I am convinced they are no more than phases of *F. septica* developed under certain conditions, and that *F. intermedia* is not a valid species. The opinion is fortified by the references to ecorticate aethalia in the descriptions and notes of *F. septica* as given in the various editions of the Lister Monograph, to which the reader is referred. N. Y. B. G. Nos. *9387, 9388, 9389, 9390.*

KLEISTOBOLUS PUSILLUS Lipp. This small inconspicuous species is probably very common on dead, coniferous wood, as we find it frequently associated with larger forms. The subglobose sporangia cannot be seen in the field unless acquainted therewith. They are brown in color and circular in shape, with distinct, shining lids. The species forms large colonies with many sporangia. One such found in Pike County, Pennsylvania, in August, was more than four feet in length, our idea of the size being limited by the strip of wood we brought back. N. Y. B. G. No. *2629.*

LAMPRODERMA VIOLACEUM (Fries) Rost. In the description of the species as given in the Lister Monograph, it is stated that the peridium is often sprinkled with small, hyaline rods. Four collections of this odd variation were made in Pike County, Pennsylvania, in July, August, and September, during the time that the species develops abundantly on leaves. Later, in the autumn, the species forms large colonies on wood. The hyaline rods, which are up to 100 μ in length, are usually firmly imbedded in the peridium. They appear to have a mineral nature but do not react to hydrochloric acid. N. Y. B. G. Nos. *2690, 2691, 2800, 2805.*

LEPIDODERMA TIGRINUM (Schrad.) Rost. Two small, but well matured fruitings were found on mossy logs in different areas of Pike County, Pennsylvania, in October. A larger and much better development was uncovered by W. D. Sutton and Eli Davis in Dorchester swamp, Middlesex County, Ontario, in late November. The latter extended to more than 20 feet on a dead, larch log covered with mosses. The species has not been reported often

from eastern North America. It probably fruits towards the end of the season only, and on the habitats mentioned. N. Y. B. G. Nos. *2738, 2743, 9568, 9569.*

LYCOGALA EPIDENDRUM (L.) Fries. The variety *tessellatum* was found in Pike County, Pennsylvania, in August. Collections were also made by Mr. Travis E. Brooks in Geary County, Kansas, in July, and by Mr. W. D. Sutton in Middlesex County, Ontario, in September. N. Y. B. G. Nos. *2686, 9396, 9397, 9570.*

Physarum Bilgramii nom. nov. The name is proposed in place of *Physarum lilacinum* Sturg. & Bilgr. (Mycologia **9**: 324. 1917) which is untenable under the present Rules of Nomenclature as it was used by Fries (Syst. Myc. **3**: 141. 1829) for a form now regarded as *Badhamia lilacina* (Fries) Rost.

In the Herbarium of the New York Botanical Garden are four specimens of the species collected by Mr. Hugo Bilgram at various places in and about Philadelphia during the years 1910, 1912, and 1928. They show some differences in the intensity of the lilac tint which is the only specific character, as otherwise the form is like *Physarum globuliferum* (Bull.) Pers. We have found developments of the latter species, occasionally, which show this tint in a slight degree, but not sufficiently to regard them as *P. Bilgramii.* Mr. Rispaud found in Pike County, Pennsylvania, in July, two specimens which are well marked in the lilac color, one of them close to a specimen of Bilgram, and the other somewhat paler. Both are distinctly lilac when viewed in mass by daylight. These belong here, and it is probably best to continue to recognize the form as a species for purposes of classification, although it is clear to me that the color is not due to any inherent qualities in the plasmodium. Like in the formation of various colored forms of calcite it is probably caused by the presence of a slight amount of another mineral, perhaps manganese. This other element, present in the habitat of the plasmodium and absorbed thereby, would color the lime. Similar conditions are found in *P. citrinum* Schum., and *P. murinum* List. where many forms intermediate in color with *P. globuliferum* are found, and deeply colored forms are rarer. It would be interesting to develop laboratory cultures from some of these forms and see if the resulting fruit would show continued

tints, or revert to the white of *P. globuliferum.* N. Y. B. G. Nos. *2785, 2787.*

PHYSARUM GLOBULIFERUM (Bull.) Pers. In Mycologia **30**: 349. 1938, I reported a collection with *Badhamia*-like capillitium. A similar development was found in Pike County, Pennsylvania, in August, which also has large, white, angular or branching lime-knots. Other characters are those of *P. globuliferum.* It is possible that similar forms will be found more frequently in calcareous regions, and the conception of the species should be broadened to cover them along with the usual phase having small, rounded lime-knots. N. Y. B. G. No. *2769.*

PHYSARUM LISTERI Macbr. Collected by Travis E. Brooks and Mrs. Brooks in Riley County, Kansas, in September. The species has now been found repeatedly in Colorado, Kansas, North Carolina, Tennessee, Virginia, and Quebec, showing a wide distribution. It fruits on old leaves and is probably not uncommon. N. Y. B. G. No. *9406.*

PHYSARUM MUTABILE (Rost.) List. An undoubted specimen of the species has come here from Dr. Roy F. Cain of the University of Toronto, collected by W. R. Watson at Bear Island, Lake Timagami, Ontario, in September 1923. The specimen, on an herbaceous stalk, is scanty unfortunately, but sufficient to recognize the species. The white, sessile, subglobose, and rugolose sporangia have single walls with evenly distributed lime-granules. The capillitium is a close, persistent, network of pale, hyaline threads, with few lime-knots, the lime generally aggregated in the center to form a clavate columella to the top of the sporangium, or shorter, or missing entirely. The spores are purple-brown, minutely spinulose, 9–10 μ diam. The specimen agrees in every particular with authentic specimens from England, Moldavia, and Italy, in the Herbarium of the New York Botanical Garden.

When stalked, the sporangia bear a superficial resemblance to some phases of *Craterium aureum* (Schum.) Rost., but can be distinguished by the persistent capillitium which retains the sporangial shape after dehiscence and spore dispersal. It is said to form large colonies, and should be found again in greater abundance in

the forests of Ontario and Quebec on heaps of old leaves, straw, etc. N. Y. B. G. No. *9551.*

PHYSARUM OVISPORUM G. List. I have received from Mr. Travis E. Brooks two specimens collected in Riley County, Kansas, in September, that are much nearer to the published description of this species than those reported from Long Island in Mycologia **29**: 404–405. 1937. The sporangia are sessile and white; the lime-knots in the capillitium are numerous, of varying sizes and rounded, with very few angular; the spores are rather dark, dull, purplish-brown, and almost all of them are distinctly ovoid in shape. The minor differences seem to be of little importance if the principal distinguishing characters of the species are the ovoid spores combined with the rounded lime-knots. The two collections are regarded here as *P. ovisporum.* N. Y. B. G. Nos. *9411, 9412.*

PHYSARUM SUPERBUM Hagelstein. Several collections were made by Travis E. Brooks, John Hudspeth, and J. Koepper in Geary and Riley Counties, Kansas, in June, August, and September, and also by Eli Davis and W. D. Sutton at Mount Brydges, Ontario, in October. Considerable range in color is shown by the various specimens, but this is characteristic, and due to varying conditions prevailing at the time of fructification. N. Y. B. G. Nos. *9415, 9416, 9417, 9571, 9572.*

STEMONITIS FUSCA Roth. I have often been asked the question as to how long specimens of the Mycetozoa will keep when properly boxed. In the Herbarium of the New York Botanical Garden there is a specimen of *S. fusca* collected on Staten Island, New York, in July 1818, and another found at White Sulphur, Virginia, in June 1838. That should be a sufficient answer. N. Y. B. G. Nos. *6557, 6798.*

STEMONITIS VIRGINIENSIS Rex. The species is based entirely upon the spore characters. All others are of little importance. The spores are pale lilac-brown, 6–8 μ diam., and reticulated with narrow, raised bands, the meshes ranging from 6 to 12 on the hemisphere in the specimens we have here. The color of the sporangia varies slightly; the size varies from 2 to 12 mm. or

more; and they may be cylindric or acuminate. The stalks may be long or short. The form is a *Stemonitis* because occasionally the surface net is well developed to nearly the apex of the sporangium. More often it is developed only in the lower part, or not at all, when the form looks like a *Comatricha* with many free ends to the capillitium. A specimen in the Herbarium of the New York Botanical Garden collected by Rex at Mountain Lake, Virginia, the type locality—but not regarded as part of the type collection although it may be—has a poorly developed net with many free ends. The spore characters are remarkably uniform throughout these various phases, and are different from those of any other *Stemonitis*.

Comatricha reticulata Gilb. (Am. Jour. Bot. **19**: 140. 1932) is probably a phase of the present species, judged by the description which reads like a description of *S. virginiensis* except for slight irregularities in the capillitium. Many specimens in the Herbarium of the New York Botanical Garden.

TRICHIA ALPINA (R. E. Fries) Meylan. A specimen has come from Dr. Roy F. Cain of the University of Toronto, collected by G. D. Darker at Lake Timagami, Ontario, in 1923. The fructification is in short plasmodiocarps with dark, thick walls. The elaters of the capillitium are yellow, 4–5 μ thick, with close, regular spirals. The spores are yellow, faintly marked with warts or spines, and measure 15–18 μ diam. An inner wall is not evident. N. Y. B. G. No. *9425*.

THE NEW YORK BOTANICAL GARDEN

CONTRIBUTIONS TO THE MYCOFLORA OF BERMUDA—II

F. J. Seaver and J. M. Waterston

(with 2 figures)

In connection with the mycological explorations of Bermuda the writers noted an unusually large number of specimens of the genus *Stictis*. Comparative study revealed the fact that there are not only numerous specimens, but that they apparently comprise several distinct species.

The genus *Stictis,* while in a broad sense included with the Discomycetes, is usually placed in the order Phacidiales, while the term Discomycetes is often restricted to the Pezizales. The genus which is at least a close ally of the Discomycetes is characterized by its usually rounded but occasionally slightly elongated apothecia which are at first immersed in the host substratum, later dehiscing with a prominent margin which may remain entire or become split into several rays or lobes, the hymenium remaining below the surface of the substratum. The exposed margin is usually white, but may be occasionally slightly colored. The spores are filiform and usually nearly as long as the ascus.

The type species *Stictis radiata* is common on wood and twigs. A number of the Bermuda species occur on leaves and herbaceous stems. The following is a summary of the forms encountered in Bermuda. This contribution is based on collections made on the three expeditions, as outlined in the first of the series of papers (see Mycologia 32: 388. 1940).

Key to the Species of Stictis Occurring in Bermuda

On dicotyledonous hosts (rarely on both monocots and dicots).
- Spores 100 μ or more in length.
  - Exposed margin of apothecia white, more or less laciniate or crenate.
    - Spores 140–150 μ long. ....1. *S. radiata.*
    - Spores 100–110 μ long, on *Conocarpus*. ....2. *S. Conocarpi.*

Exposed margin of apothecia pink, nearly even, scarcely laciniate, on some herbaceous stem. ....3. *S. carnea.*
Spores less than 100 μ long, usually 70–75 μ.
Apothecia margin usually 5-lobed on *Coccolobis*....4. *S. Coccolobii.*
Apothecia margin usually 4-lobed on *Pimenta*......5. *S. Pimentae.*
On monocotyledonous hosts.
Apothecia white, rounded, spores 175–180 μ long, on banana sheaths. 6. *S. Musae.*
Apothecia much elongated about 3 times as long as broad, spores 50–60 μ long, on sheaths of grass. ....7. *S. lophodermioides.*
On fern stipes, *Acrostichum excelsum* Maxon ....8. *S. filicicola.*

1. STICTIS RADIATA (L.) Pers. ex Fries, Syst. Myc. 2: 194. 1822 (FIG. 1*a*).

Specimens collected on old flowering stalks of *Agave* appear to be this species, although apparently not previously reported on this host. Brown, Britton & Seaver *1336*; Seaver & Whetzel *47.*

2. **Stictis Conocarpi** sp. nov. (FIG. 2*a*).

Apothecia sparingly scattered, at first immersed becoming erumpent, the margin splitting into several lobes (usually about 4), white, not exceeding .5 mm. in diameter; hymenium darker; asci cylindric 125 × 10–12 μ; spores filiform 100–110 μ long; paraphyses filiform.

Apotheciis sparsis primo immersis dein erumpentibus, candidis, margine prominulo laciniato; ascis cylindraceis, 125 × 10–12 μ; sporiis filiformibus, 100–110 μ long; paraphysibus filiformibus.

On leaves of *Conocarpus erecta* L., Seaver & Whetzel *10.*

3. **Stictis carnea** sp. nov. (FIG. 1*c*).

Apothecia gregarious, not exceeding .5 mm. in diameter, at first immersed, the margin becoming slightly prominent, the entire fungus and surrounding tissue flesh-colored, the inside of the exposed margin lighter, almost white, the margin nearly even and only slightly elevated; asci cylindric, tapering above, 8-spored, reaching a length of 225–250 μ and a diameter of 12 μ; spores filiform, many-septate reaching an extreme length of 200 μ or rarely more, and a diameter of 3–4 μ; paraphyses very slender, scarcely more than 1 μ in diameter.

Apotheciis gregariis .5 mm. diam. in subiculo carneo primo immersis dein erumpentibus, margine prominulo carneo non laciniato; hymenio leniter carneo; ascis cylindraceis, 225–250 μ long., 12 μ diam.; sporiis filiformibus 200 μ long., 3–4 μ diam.; paraphysibus filiformibus vix 1 μ diam.

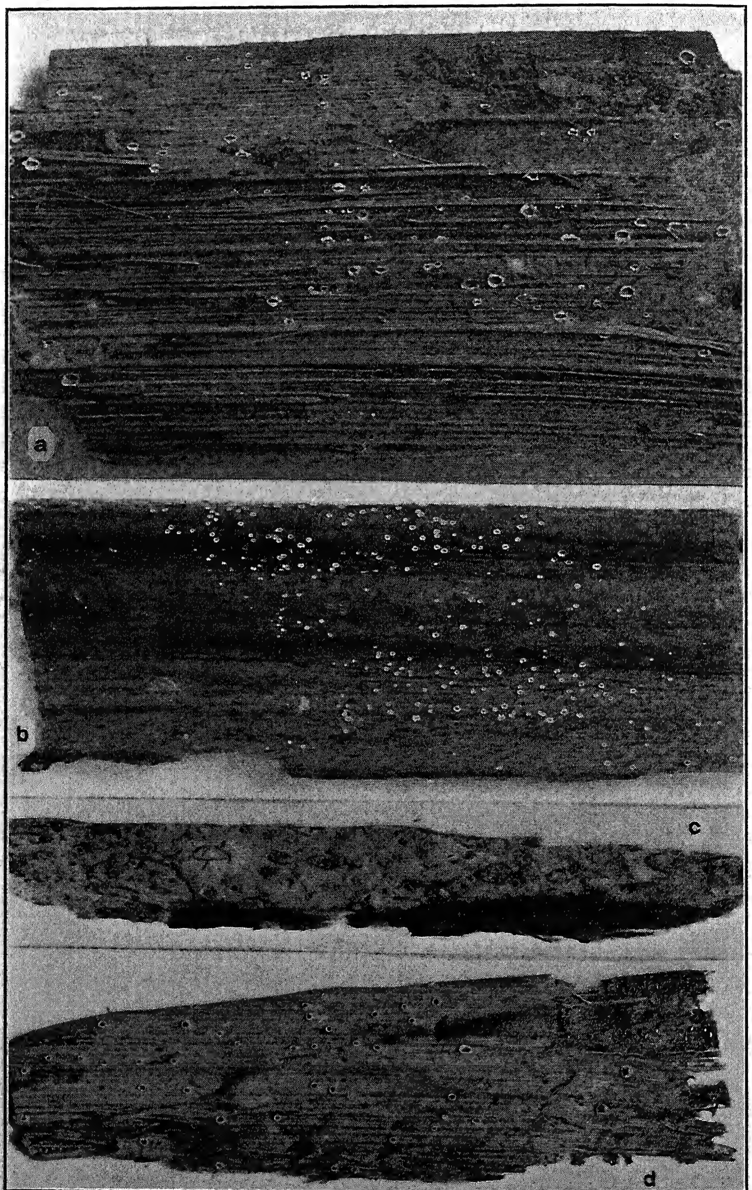


FIG. 1. *a, Stictis radiata; b, Stictis filicicola; c, Stictis carnea; d, Stictis Musae.* $\times$ 2.5.

On some undetermined stems, Seaver & Whetzel *5*. Fruitlands, Jan. 15, 1926.

4. STICTIS COCCOLOBII Seaver & Waterston, Mycologia **32**: 399. 1940.

On fallen leaves of *Coccolobis uvifera* (L.) Jacq. Seaver & Waterston *13, 196;* Seaver & Whetzel *26, 62, 79.*

5. **Stictis Pimentae** sp. nov. (FIG. *2b*).

Apothecia rather thickly scattered over the underside of the leaves, scarcely exceeding .5 mm. in diameter, at first immersed becoming erumpent, the epidermis of the host folding back in several (usually 4) lobes, exposing the hymenium which is nearly white; asci cylindric, reaching a length of 70–75 μ and a diameter of 8 μ; spores nearly as long as the ascus (difficult to remove) and about 2 μ thick, many-septate; paraphyses very slender, about 2 μ thick.

Apotheciis sparsis plerumque hypophyllis, .5 mm. diam. primo immersis dein erumpentibus laciniatis, niveis; hymenio pallido; ascis cylindraceis, 70–75 μ long., 8 μ diam.; sporiis filiformibus pluriseptatis 65–70 μ long.; paraphysibus filiformibus 2 μ diam.

On leaves of allspice *Pimenta officinalis* Lindl. Collected at Fruitlands, Jan. 15, 1926, Seaver & Whetzel *8;* also near the Experiment Station, Jan. 27, 1926, Seaver & Whetzel *51.*

6. **Stictis Musae** sp. nov. (FIG. 1*d*).

Apothecia thickly gregarious, deeply immersed becoming erumpent with the margin prominent slightly rolled back, nearly even not laciniate, white, the hymenium slightly pinkish; asci subcylindric reaching a length of 180–200 μ; spores nearly as long as the ascus and about 2 μ in diameter, many-septate (usually about 40); paraphyses present very slender.

Apotheciis gregariis, erumpentibus, margine prominulo non laciniato, candido, hymenio pallido vel leniter carneo; ascis subcylindraceis, 180–200 μ long.; sporiis filiformibus, multiseptatis; paraphysibus filiformibus.

On the sheaths from banana stems (*Musa* sp.), Seaver & Whetzel *76.*

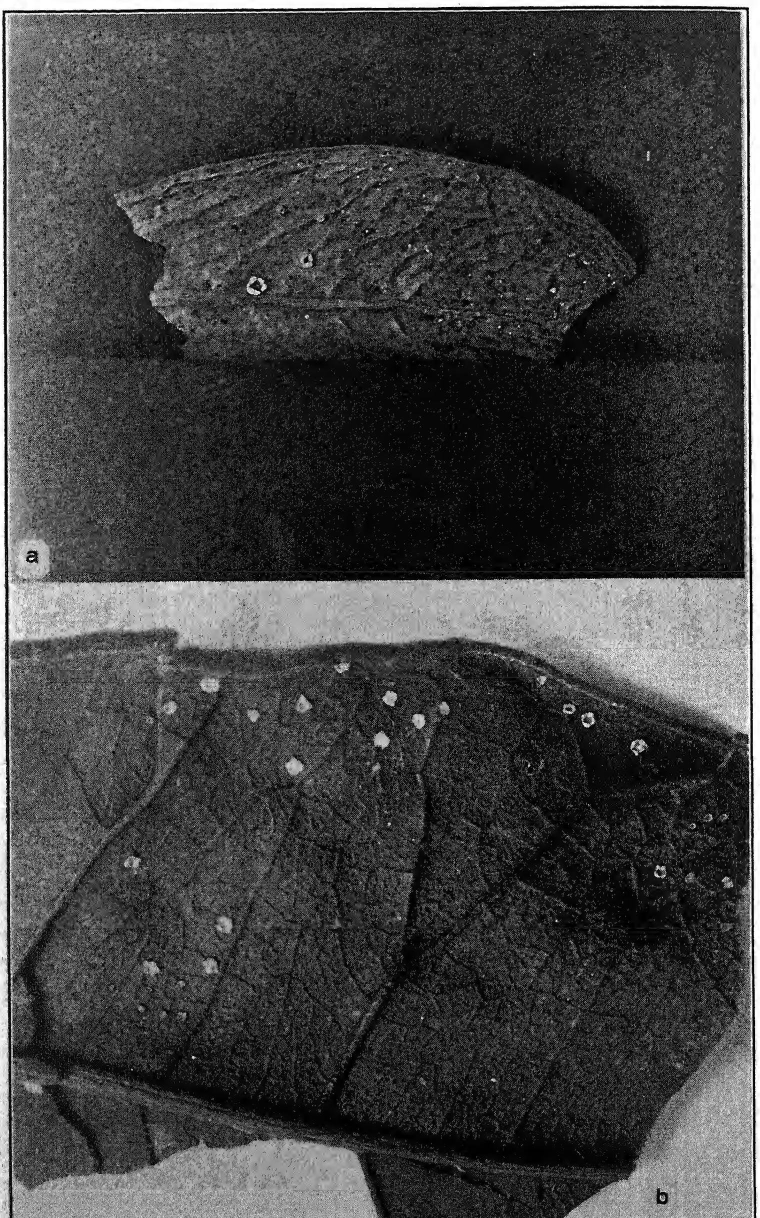


FIG. 2. *a, Stictis Conocarpi; b, Stictis Pimentae.* × 2.5.

7. STICTIS LOPHODERMIOIDES Seaver & Waterston, Mycologia 32: 400. 1940.

On stems of grass. Brown, Britton & Seaver *1469*.

8. **Stictis filicicola** sp. nov. (FIG. 1*b*).

Apothecia gregarious, minute .3–.5 mm. diam., rounded or slightly elongated, immersed, bursting open, the exposed inner margin pure white scarcely laciniate, nearly even or delicately crenate; hymenium sunken, somewhat darker than the exposed margin; asci cylindric reaching a length of 180–200 μ and a diameter of 8 μ, 8-spored; spores filiform reaching a length of 100–150 μ, usually about 120 μ, many-septate, usually with about 30 septa which are about 4–6 μ apart; paraphyses filiform, about 1–1.5 μ in diameter.

Apotheciis gregariis, .3–.5 mm. diam. primo immersis, dein erumpentibus candidis, margine prominulo vix laciniato; hymenio pallido; ascis cylindraceis, 180–200 μ long., 8 μ diam.; sporiis filiformibus, 100–150 μ long. multiseptatis, paraphysibus filiformibus, 1–1.5 μ diam.

On stipes of giant fern (*Acrostichum excelsum* Maxon), Brown, Britton & Seaver *1322*.

RECENT OBSERVATIONS

Since the above was written the senior writer made a fourth visit to Bermuda, covering the period from November 24 to December 12, 1940, to work in collaboration with the junior author. Although our work during this short period was impeded by a rather unusual rainfall, numerous collections were obtained and a number of observations bearing on the present report were made. A special effort was made to check up on the species reported here and in the previous contribution as new to science.

In 1912 specimens were collected abundantly on old poles of *Agave* which were referred to *Stictis radiata* the type species, and one which is known on woody and occasionally on herbaceous stems throughout North America, the West Indies and into South America. During our recent visit numerous poles of *Agave* have been carefully examined, but this fungus was not again found. It may be located later.

The second species listed here, *Stictis Conocarpi,* was collected sparingly on leaves of *Conocarpus erecta* L. by H. H. Whetzel on

Jan. 22, 1926. Although a diligent search was made for this it was not re-collected. This may be due to the fact that it was not the proper season. Other attempts will be made to locate the species which seems distinct.

Not knowing the habitat of the third species mentioned we had no clue on which to work, and no special attempt was made to locate it.

The fourth species recorded here, *Stictis Coccolobii,* was described by the authors in a previous paper (Mycologia **32**: 399, *f.2*) from material collected by them on December 13, 1940, at Grape Bay. The same region was searched during our recent foray and this species was again found to be abundant on the fallen leaves provided the conditions were favorable, for not only is it necessary to have the proper host but the conditions of moisture must also be right.

The fifth species, *Stictis Pimentae,* here described as new was first collected in 1926 near the Agricultural Station and at Fruitlands, Warwick, on fallen leaves of allspice. Special search was made in Warwick Parish where the host was known to occur and spread freely, and the fungus was again found to be present and apparently well established on the fallen leaves of the host indicated above. At the same time it was not detected on the leaves of any other plant.

The sixth species recorded in this paper, *Stictis Musae,* was collected on banana petioles in a garden near the Agricultural Station, February 2, 1926. During our recent visit it was not found. Possibly it occurs later in the season.

The last species referred to in this paper, *Stictis filicicola,* occurred on the petioles of the giant fern *Acrostichum excelsum* Maxon. This was at first also referred to *Stictis radiata.* Recent comparative studies, however, have convinced the writers that this is a distinct species. On November 28, 1940, a visit was made to Paget Marsh where the giant fern grows in great profusion. One of our objects was to re-collect if possible this fungus. Almost the first handful of dead stems of this fern showed the *Stictis* to be present in great abundance. A careful search was then made of other ferns, including *Osmunda cinnamomea* L., as well as the

stems of other plants, but the fungus was not found on any other host. The persistence of this fungus on the petioles of *Acrostichum* over a period of twenty-eight years tends to confirm our belief that it is specifically distinct.

EXPLANATION OF FIGURES

All photographs are made from dried material and enlarged about 3 times.

THE NEW YORK BOTANICAL GARDEN
AND
AGRICULTURAL EXPERIMENT STATION,
PAGET EAST, BERMUDA

MYCOLOGICAL NOTES. V

C. L. Shear

A critical examination of some of our common North American Pyrenomycetes and comparison with those of Europe shows that they have been erroneously identified. This might naturally be expected when it is remembered that the early mycologists, such as Fries and Schweinitz, did not describe the spores and other microscopic characters which are now known to be of great importance in specific determinations. A vast amount of study of type and authentic material of the older species must be made before any dependable lists of our species can be made and their synonymy determined, or any reliable data regarding their distribution obtained. The specimens of our common species even in our largest herbaria are so few and the material usually so poor and scanty that no satisfactory monographic studies can be made. One of our greatest needs for the advancement of mycological taxonomy is more and better material from all parts of the country and the world.

17. Nummularia Bulliardi Tul. Sel. Fung. Carp. **2**: 43. *pl. 5, f. 11–19.* 1863

This fungus was first described according to Fries (Syst. Myc. 2: 348. 1823) by Micheli (Nov. Pl. Gen. 105, No. 5. 1729). However, Micheli's brief description without illustration is very doubtful. The only specimen of *Nummularia* Saccardo could find in Micheli's herbarium was *N. repandoides* Fuckel. (*N. clypeus* (Schw.) Cooke) labelled "Lithophytoides." The fungus was described by Bulliard (Champ. France **1**: 179, *tab. 468, f. 4.* 1791) as *Hypoxylon nummularium.* His illustration seems to leave little doubt that he had the fungus renamed as above by Tulasne. The typical form is on beech, and shows the striking nummular shape almost exactly circular and about the size of a small coin. DeCandolle next described it as *Sphaeria nummularia,* Fl. Fr. **2**: 290.

1805. Fries (l.c.) cites *S. macula* Tode (Fungi Meckl. 2: 33, *pl. 13, f. 106.* 1791) but the description and illustrations do not agree with Tulasne's fungus. He also cites *S. diffusa* Sow. Engl. Fungi, *pl. 373,* 1802, and *S. orbicularis* Pers. ined., as synonyms. We next find the fungus described by Schmidt as *S. anthracina* in Kunze & Schmidt, Myk. Hefte **1**: 55, *tab. 2, f. 14.* 1817. The illustration cited leaves no doubt that it is the same as that so fully described by Tulasne. The subglobose ascospores shown are typical.

Tulasne (l.c.) gives a very complete description and illustrations of the fungus, including its conidial stage. He cites *S. diffusa* Sow., as a doubtful synonym; also *S. anthracina* Schmidt (l.c.). He says the conidia develop under the bark and break through the clefts in the form of a very abundant pure white powder consisting of very minute spores hardly more than 5 μ in diameter. The loosened bark is covered on its inner surface with a rather thick stratum of fleshy, dingy white fungus parenchyma. We have observed specimens of *N. clypeus* (Schw.) Cooke in its conidial condition on oak from Virginia with a similar growth. Tulasne (l.c. 45) reports it on beech only, and says that among the specimens found in the herbarium of the Paris Museum which agree best in form and habit with this species, are *Sphaeria clypeus* Schw. from North America, *S. anthracodes* Fries from Brazil and Chile, and *S. pachyloma* Lév. The specimen of *S. clypeus* to which he refers is probably that sent by Schweinitz to Brongniart about 1823, before Schweinitz had abandoned his name and labelled his specimens *S. nummularia* (Bull.) Fries.

Nitschke (Pyren. Germ. 60. 1867) cites Currey's figure (Act. Soc. Linn. Lond. **22**: 268. *f. 59.* 1858) as representing this fungus and also DeNotaris (Microm. Ital. **9**: *f. 1.* 1853) as well as the following exsiccati: Moug. & Nestl. Stirp. Vog. Rhen. *374,* and Fuckel, Fungi Rhen. *1062.* Following the description he says: "I succeeded in finding the conidial stage as described by Tulasne on fallen beech trunks. The fine powdery conidia covered the disk of the stroma with a chalk-like layer which finally disappeared and left the surface a dark earthy brown color. This disappears and the surface becomes blue-gray with black punctate ostioles." He found it only on *Fagus sylvatica,* but mentions that Fries reports it

on other hosts. He describes the ascospores as oval to subglobose, measuring 12–14 × 6–10 μ. Fries (Summa Veg. Scand. 384. 1849) records it as *Hypoxylon nummularium* Bull. and reports it as found in Scandinavia, citing Berk. Brit. Fun. Exs. *28*. We have not seen this number.

Ellis and Everhart (N. Am. Pyren. 624. 1892) describe *N. Bulliardi,* and give the spore size as 12–15 × 7–9 μ, which is the size of spores in typical specimens of this species in Europe. They cite as examples Rab. Fungi Eur. *2956;* and Rehm Ascom. *977* which are typical *N. Bulliardi.* Ellis and Everhart N. Am. Fungi *85* is typical *N. clypeus* on oak. Under *N. clypeus,* Ellis and Everhart (No. Amer. Pyren. 627–28) translate Schweinitz' original diagnosis and give the spore measurements as 20 × 8 μ, which agrees with those given by Cooke, and add "On branches of *Catalpa,* Curtis; on oak, Ravenel."

An examination of numerous European and American specimens shows that these two species are easily separated, especially by the size and shape of the ascospores. Ellis, however, was mistaken in referring American specimens, mostly on oak, to *N. Bulliardi,* since his No. *85* cited above and other specimens identified by him and others in this country are not *N. Bulliardi* Tul. Schweinitz in his original description gives *Tilia* and *Acer rubrum* as hosts for his *Sphaeria nummularia* (*S. clypeus* Schw.).

We have examined the following European specimens of *N. Bulliardi:* P. Strasser, Sonntagsberg, on beech, spores 9–14 × 6–9 μ; Fuckel, Fungi Rhen. *1062,* issued as *Hypoxylon* on *Fagus,* Nassau, spores 9–13 × 6–9 μ; Krypt. Exs. Mus. Pal. Vind. *516,* issued as "*N. nummularia* (Bull.) Keissl.," collected by Niessl, Brunn, on *Fagus,* spores 9–13 × 6–9 μ. All the specimens of true *N. Bulliardi* we have seen are on *Fagus.* Fries and Traverso report it on "*Acer, Carpinus, Castanea, Quercus,* etc."

DeNotaris (Micro. Ital. **9**: *pl. 1, f. 1–6.* 1857) under *Hypoxylon nummularium* excludes as a synonym Tode's *S. macula.* He cites Berkeley, British Fungi *240.* 1837. He also says that the synonym cited by Fries from Micheli is probably wrong as the description seems to him to apply to *Sphaeria stigma* Hoffm. or a variety of it. *S. macula* Tode he thinks also relates to *Sphaeria stigma* instead of this species and quotes Tode's words to that

effect. DeNotaris' Italian specimen cited was on dead branches of *Fagus* from the Apennine Mountains, collected by Cesati. He says it is rare. His illustration (l.c.) shows the nummular form of stroma with the typical subglobose to short, broadly elliptical ascospores. We have not yet seen a specimen of this species gathered in North America. The numerous American specimens under this name in the Lloyd, Ellis, and other Herbaria examined are mostly *N. clypeus* (Schw.) Cooke. The synonymy would appear to be as follows:

NUMMULARIA BULLIARDI Tul. Sel. Fung. Carp. **2**: 43. *pl. 5, f. 11–19.* 1863.

Hypoxylon nummularium Bull. Champ. Fr. **1**: 179. *pl. 468, f. 4.* 1791.

Sphaeria nummularia DC. Fl. Fr. **2**: 290. 1805.

Sphaeria anthracina Schmidt in Kunze & Schmidt, Myk. Hefte **1**: 55. *pl. 2, f. 14.* 1817.

Sphaeria nummularia (Bull.) Fries, Syst. Myc. **2**: 348. 1823.

Nummularia nummularia (Bull.) Schröt. Pilz. Schles. **2**: 458. 1897.

Nummularia anthracina (Schm.) Trav. Fl. Ital. Crypt. Pyren. **1**: 57. *f. 10.* 1906.

Kommamyce Bulliardi (Tul.) Nieuwland, Amer. Mid. Nat. **4**: 375. 1916.

Numulariola nummularia (Bull.) House, N. Y. St. Mus. Bull. **266**: 49. 1925.

18. NUMMULARIA CLYPEUS (Schw.) Cooke, Grevillea **12**: 6. 1883

Schweinitz under *Sphaeria* (Schr. Nat. Ges. Leipzig **1**: 31. 1822) described this species as follows:

42. (S.) Clypeus Sz. numularia Decand. Flor. Gall. II, p. 290. Bulliard, t. 480. 3?

S. explanata ambitu elliptico immersa atro-nitens, ostiolis conicis prominulis exasperata.

Totus fungus cortici etiam vivarum arborum, Tiliae, Aceris rubri, immersus, clypeolum unciam unam ad tres longum, dimidiam latum refert affixum claviculis, quorum capitula (ostiola sphaerularum) prominent; margine ligneo undulato cingitur. Facile potest excuti e lecto suo, cavitatem in ligno linquens.—Dura. Stroma nigrum parcius. Sphaerulae majores, profundius penetrantes. Pulvere seminali brunneo tecta reperitur interdum.

Later (Trans. Am. Phil. Soc. II. **4**: 193. *No. 1219*. 1832) he mentions it as follows:

1219. 73. S. numularia, F. 57, Syn. Car. 42, S. clypeus, inveni specimina Pennsylvania septam uncias longa et lata 3–4. In variis-praecipue Quercus.

Fries also cited *S. clypeus* as a synonym of *Sphaeria nummularia* Fries in Syst. Myc. **2**: 348. 1823.

A careful examination of Schweinitz' specimens indicates that they are all clearly distinct from *Hypoxylon nummularium* Bull. as was pointed out by Tulasne and Cooke (Grevillea **12**: 6. 1883). Tulasne (Sel. Fung. Carp. **2**: 44. 1863) who examined a part of Schweinitz' original specimen, says in a foot-note: "This pyrenomycete (*S. clypeus* Schw.) which grows usually on oak is rightly distinguished from our first *Nummularia* (*N. Bulliardi*) as appears from the words of Schweinitz himself both by the capitate and prominent ostioles of its conceptacles and by the brown seminal powder with which it is sometimes found covered." He also mentioned the very noticeable difference in size and shape of the ascospores. The specimen still remaining in the original packet in Schweinitz' herbarium with a gummed paper strip attached is probably from the original Salem collection. It has spores 14–17 × 7–9 μ. There is another specimen in the mounted collection of his herbarium labelled "*Sphaeria numularia β striata* N. York." This is immature. The surface of the stroma is brown and the ostioles not so conspicuous as usual. The surface is somewhat striate, due apparently to linear irregularities in the inner surface of the bark of the host. The spores in this are typical, 14–18 × 7–9 μ. As noted in our discussion of *N. Bulliardi,* Ellis' N. A. Fungi *85* on oak cited as that species has spores 15–17 × 6–7 μ and is not *N. Bulliardi* Tul. (*Sphaeria nummularia* Fries), but *N. clypeus* (Schw.) Cooke.

We have examined specimens of *N. clypeus* from many states from Maine and Canada to Florida and west to Washington, Oregon and California on various hosts, including *Acer, Alnus rubra, Carpinus, Carya alba, Castanea, Diospyros, Fagus, Pasania densiflora, Quercus* spp., and *Rhus.* It occurs most frequently on oak and beech. Nearly all are labelled *N. Bulliardi.*

It is also found in Europe where it was described by DeNotaris (Microm. Ital. **6**: 4. *f. 2.* 1851) as *Sphaeria mediterranea* (*Nummularia mediterranea* Sacc., *N. regia* var. *mediterranea* Trav.). An examination of DeNotaris' specimen in his herbarium at Rome shows that it agrees in every respect with *N. clypeus.* A mere form of this species was also described by DeNotaris (Sfer. Ital. 15. *f. 12.* 1863) (*Nummularia regia* [DeNot.] Sacc.) as *Hypoxylon regium.* This was also illustrated by Saccardo (Myc. Ven. *pl. 15, f. 37–40.* 1873, and Fung. Ital. *f. 585.* 1879). Traverso (Fl. Ital. Crypt. Pyren. **1**: 59. 1906) says that *N. mediterranea,* which he reduces to a variety of *N. regia* as above, differs especially in having the surface of the stroma irregular. From an examination of DeNotaris' specimen it is evident that this is due to the fact that the fungus was growing on thick, rough bark which causes the irregularities. The spores and all other characters are identical with those of *N. regia* and *N. clypeus.* Miller (Trans. Brit. Myc. Soc. **17**: 129. 1932) says he has seen specimens of *Hypoxylon mediterraneum* (DeNot.) Miller from Holland, Germany, and France. We have a fine specimen on *Quercus suber* from Portugal as *N. regia.*

This species was also described by Fuckel (Symb. Myc. 236. *pl. 2, f. 46.* 1869) as *N. repandoides.* A study of Fuckel's specimen (Fungi Rhen. *2266* on *Fagus*) shows that this also is identical with *N. clypeus.* We have one other specimen of *N. clypeus* on *Fagus* from Hanover, Germany, distributed by Rehm in his Ascom. *1769,* incorrectly named *N. anthracina* (K. & S.) Trav. The spores are 15–18 $\times$ 7–8 μ. The papillate ostioles and other characters agree with typical *N. clypeus* on beech in this country. Curiously enough Rehm issued under the same name as "forma juvenilis" his No. 1769–b, typical *N. Bulliardi* Tul. on *Fagus* from upper Bavaria. The great bulk of the material in herbaria in this country labelled *N. Bulliardi* is *N. clypeus.* We have yet to see a specimen of the true *N. Bulliardi* Tul. from North America. Saccardo (Syll. Fung. **1**: 396. 1882) gives *N. clypeus* as a synonym of *N. Bulliardi,* but later (Syll. Fung. **9**: 570. 1891) he follows Cooke (l.c.) in describing it as a separate species.

The synonymy so far as we know it at present is as follows:

NUMMULARIA CLYPEUS (Schw.) Cooke, Grevillea **12**: 6. 1883.

Sphaeria clypeus Schw. Schr. Nat. Ges. Leipzig **1**: 31. 1822.

Sphaeria nummularia Schw. Trans. Am. Phil. Soc. II. **4**: 193. 1832. Non Fr.

Sphaeria mediterranea DeNot. Microm. Ital. Dec. **6**: 4. *f. 2.* 1851.

Hypoxylon regium DeNot. Sfer. Ital. 15. *f. 12.* 1863.

Hypoxylon clypeus (Schw.) Curt. Cat. Pl. N. Car. 140. 1867.

Nummularia repandoides Fuckel, Symb. Myc. 236. *pl. 2, f. 46.* 1869.

Nummularia mediterranea (DeNot.) Sacc. Syll. Fung. **1**: 400. 1882.

Nummularia regia (DeNot.) Sacc. Syll. Fung. **1**: 400. 1882.

Nummularia bulliardi Ellis & Ev. N. Am. Pyren. 624. 1892. pp. Non. Tul.

Nummularia regia var. *mediterranea* (DeNot.) Trav. Fl. Ital. Crypt. Pyren. **1**: 59. 1906.

Hypoxylon mediterraneum (DeNot.) Miller, Trans. Brit. Myc. Soc. **17**: 129. 1932.

19. ROSELLINIA AQUILA (Fries) DeNot.

This pyrenomycete has been generally regarded as a common species throughout most of Europe and the United States, and has also been reported from China and other regions. It was described as *Sphaeria aquila* Fries, Vet. Akad. Hand. **1817**: 251. It was also described by Fries in Syst. Myc. **2**: 442. 1823. He cites Schmidt and Kunze, Deutsch. Schwäm. Exs. *52,* labeled "*Sphaeria byssiseda* P." as representing his species. No description of spores was given. Those in the specimen of this number we have examined are 15–21 × 6–8 μ. DeNotaris (Giorn. Bot. Ital. I: 334. 1844) described the genus *Rosellinia* using Fries' species, *R. aquila,* as the type. Tulasne (Sel. Fung. Carp. **2**: 250. *pl. 33, f. 1–6.* 1863) gave a full description and illustration of this fungus. These agree entirely with the specimens of Schmidt & Kunze cited by Fries and leave no doubt as to the identity of the species. Besides the ascospores he describes and illustrates the conidial stage which is produced on the brown byssoid subiculum in which the perithecia are embedded. The conidia are borne in pale ashy-brown

corymbs. They are narrow ovate, hardly more than 10 μ long. The conidial stage according to Tulasne has been described under various names as *Sporotrichum fuscum* Lk., *S. badium* Link, and *S. stuposum* Link (Ges. Nat. Freunde Berlin Mag. **3**: 10. 1809), also as *Alytosporium fuscum* Link (Willd. Linn. Sp. Pl. IV. **6**^{2}: 23. 1825, and as *Thelephora vinosa* Pers. and *Hypochnus fuscus* Fries. He gives the ascospore measurements as about $20 \times 7\ \mu$.

Tode (Fungi Meckl. **2**: 10–11. *f. 69–70.* 1791) described *Sphaeria byssiseda* with two varieties α *grisea, f. 69* and var. β *fusca, f. 70.* The variety *grisea* he says differs from *fusca* generally in having a livid gray color and smaller perithecia. Tode's description and illustrations leave little doubt that he had the same fungus described by Fries although no spore measurements are given and no specimens of his are known to exist. Fries (l.c.) cited *S. byssiseda β fusca* of Tode, as a synonym of his *S. aquila.* Tode's var. α *grisea* Fries describes as a separate species under the name *S. byssiseda,* asserting that it is "bene distincta," and emphasizing the livid gray color and the broadly effuse subiculum. Most subsequent authors, however, regard both of Tode's varieties as mere forms of Fries' *S. aquila.* Berkeley, for example, in Smith's English Flora **5**: (pt. 2, Fungi) 260. 1836, says that Tode's varieties which Fries says are distinct "run very much into one another." The gray form with scattered perithecia is apparently a young condition with abundant production of gray conidia.

Brefeld (Unters. Gesammt. Myk. **10**^{2}: 259. 1891) recognizing the great similarity between this species and certain species of *Hypoxylon,* decided that it really belonged to that genus and called it *H. aquila* (Fries) Bref. Schröter (Krypt.-Fl. Schles. **3**^{2}: 299. 1894) adopted Tode's specific name and transferred it to *Rosellinia* on the basis of priority. Tulasne had also pointed out that the fungus has many truly hypoxyloid characters, the conidia being very similar to those of some species of *Hypoxylon* and the perithecia sometimes coalescing. In view of our present knowledge of the relationship of this genus, it is difficult to understand why it should be placed in a different family from *Hypoxylon* as has been done by Kirschstein (Trans. Brit. Myc. Soc. **18**: 306. 1934). According to numerous European specimens we have examined the ascospores vary from $14–23 \times 6–8\ \mu$, mostly about $16–18 \times 6–8\ \mu$.

Kirschstein (l.c. 302), says that the mature ascospores have small, globose, hyaline appendages at each end which are a distinctive character. Winter says "typically without appendages" and Saccardo "with or without." In the numerous European specimens we have examined we have but very rarely been able to demonstrate the presence of any such appendage. The spores at maturity are surrounded by a thin, hyaline, gelatinous envelope, and in the immature asci they are surrounded by a mucilaginous cytoplasm which connects all the spores, and some small portion of this may remain attached to their ends when the spores are set free; but it seems that only under very favorable conditions and treatment can such an appendage be found in dried specimens. In some species, as *R. thelena* (Fries) Rab., a hyaline appendage appears to be a more constant character.

R. aquila occurs on many deciduous host plants in Europe and has been regarded by American authors as one of our most common species in this country. In our early collections of this species in 1893 we noted a great discrepancy in the size of the ascospores between our specimens and those from Europe, and on the label of our New York Fungi Exs. *360* we called attention to the fact that the spores in our plant were $24–32 \times 10–13\ \mu$ instead of $15–22 \times 6–8\ \mu$ as given for the European plant. We have since examined many herbarium specimens from different parts of the United States and have as yet found but two specimens from east of the Pacific Coast which agree with *R. aquila* of Europe. They are both in the Mycological Collections of the Bureau of Plant Industry from Temple, Texas, collected by B. F. Dana 1929 and C. H. Rogers 1934. All other specimens labeled *R. aquila* thus far examined are *Rosellinia corticium* (Schw.) Sacc. or some other species. There are, however, two packets of *R. aquila,* apparently parts of the same specimen, in Mycological Collections from the George W. Clinton Herbarium of Buffalo, N. Y., but their place of collection is considered doubtful. They may be of European origin. The synonymy is as follows:

ROSELLINIA AQUILA (Fries) DeNot. Giorn. Bot. Ital. 1: 334. 1884.

Sphaeria byssiseda Tode α and β Fungi Meckl. 2: 10. *f. 69, 70.* 1791.

Sphaeria papillosa Sow. Engl. Fungi **2**: *pl. 236.* 1797. sec. Berk.

Sphaeria aquila Fries, Vet. Akad. Hand. **1817**: 251. 1817.

Sphaeria mammosa With. Bot. Arr. **4**: 360. 1830. sec. Berk.

Hypoxylon aquila (Fries) Bref. Unters. Gesammt. Myk. $\mathbf{10}^2$: 259. 1891.

Rosellinia byssiseda (Tode) Schröt. Krypt.-Fl. Schles. $\mathbf{3}^2$: 299. 1894.

20. ROSELLINIA CORTICIUM (Schw.) Sacc.

This fungus was described by Schweinitz (Schr. Nat. Ges. Leipzig 44. 1822) under *Sphaeria* as follows:

173. *Corticium* Sz.

S. simplex maxima, subiculo filoso-tomentoso orbiculari fusco, sphaerulis subsolitariis, ostiolo nigerrimo impresso.

In ramis Castaneis non infrequens. In subiculo orbiculari e fusco purpurascente plano, 4 lineas lato, corticiformi, e filis intertextis constituto, marginato, nascitur una; alterave interdum conjuncta, magnitudine fere pisi, tomento fusco purpurascente tecta. Ostiolum nigerrimum nudum, acutum.

Fries (Syst. Myc. **2**: 442. 1823) treated it as a variety of his *Sphaeria aquila.* Ellis & Everhart (N. Am. Pyren. 164. 1892) also regarded it as a variety of Fries' species. Schweinitz' specimens of this species as found in his herbarium show perithecia and spores much larger than those of *S. aquila.* He separated this species from *aquila* and others by its more or less separate and scattered perithecia and subiculum, but all sorts of intermediate conditions between it and the typical effuse form have been found. Later (Tran. Am. Phil. Soc. 210. 1832) he described as a new species *Sphaeria purpureo-fusca,* as follows:

1499. 354. *S. purpureo-fusco,* L.v.S., ramis querneis increscit passim Bethlehem, tomento crasso purpureo-fusco latissime expanso, peritheciis primum omnino tectis.

S. subiculo tomentoso racodioideo purpureo-fusco, longe lateque effuso, primum perithecia omnino tegente. Subinde obliteratur, peritheciis caespitosis, aut longitudinaliter seriatis quibus obsitum. Peritheciis ceterum maximis (imo Sphaeriae byssisedae longe majoribus), sparsis ac aggregatis, globosis, undique nisi circa ostiola tomento tenero fusco-purpureo involutis. Ostiolis atris, conicis, nudis, brevibus, interdum quasi lateralibus.

This, according to specimens in Schweinitz' herbarium is simply a form of *S. corticium* with an effuse subiculum. A portion of his

type in the Michener herbarium shows spores 21–27 × 8–10 μ, mostly 21–24 × 9 μ. A little later as No. 1503 (l.c.) he described as another new species, *S. imposita,* as follows:

1503. 358. S. imposita, L.v.S., in dejectis ramulis Bethl. occurrit infrequenter.

S. subiculo parco longitudinaliter effuso, fuscescenti, imposita sunt perithecia magma, vix immersa, ex atro-fusco, rugulosa, globosa, ostiolo subconico-papillato, sparsim seriat, interdum autem subaggregata, imo subconfluentia. A priori differt indole, magnitudine peritheciorum, et subiculo parco.

Autograph specimens of this species in the Collins Herbarium have perithecia and spores varying but very little from those of his *S. corticium* and *S. purpureo-fusca.* They are from 22–29 × 8–11 μ. Parts of the same specimen with the spores the same are also found in Schweinitz' mounted collection and in the Michener Herbarium. Cooke (Grevillea **15**: 81. 1887) transferred this species to *Byssosphaeria* as *B. imposita* (Schw.) Cooke and said that the specimen in the herbarium of Berkeley, No. *9601,* had lanceolate spores 25 × 6 μ. These spores are apparently of quite different shape from those of Schweinitz' type of this species. It is therefore very doubtful whether the specimen Cooke examined was a part of Schweinitz' type material. Saccardo (Syll. Fung. **1**: 253. 1882) transferred it to *Rosellinia.*

Besides describing three supposedly new species of *Rosellinia,* as already mentioned, Schweinitz reported *R. aquila,* No. *1497* (l.c.) which he reported as rare at Bethlehem, Pa. He also reported *R. byssiseda,* No. *1500* (l.c.) which he recorded as very common on branches, especially those of *Salix.* He also reported this species earlier from North Carolina. An examination of Schweinitz' specimens of the various species mentioned shows that they are all mere forms or conditions of his *S. corticium.* The specimen he called *S. aquila* is old, most of the subiculum has disappeared and the perithecia are somewhat more crowded than usual. He had, however, mixed with his specimens under this name an old *Hypoxylon rubiginosum,* part of which is in the Michener Herbarium. The specimen he called *S. byssiseda* in the Michener Herbarium, apparently on *Salix,* shows only young perithecia buried in the typical subiculum of *S. corticium.* No spores could be found. As neither Fries nor Schweinitz show any evidence of

having examined or measured the spores of any of their specimens, but only attempted to separate them on the basis of the character and condition of the subiculum and the size and arrangement of the perithecia, characters which have been demonstrated to be variable and to have no specific value, it is not surprising that they should have confused various forms and treated them as separate species. Wherever we have found ascospores in any of Schweinitz' specimens they agree with the measurements of his *S. corticium*.

This species is separated from *R. aquila* (Fries) DeNot. by its larger perithecia and ascospores, which vary from 18–32 × 7–12 μ, averaging about 24–26 × 8–9 μ. In *R. aquila* the spores vary from 14–23 × 6–8 μ, mostly 16–18 × 6–7 μ. There is also a difference in the conidia. Those of *R. corticium* are 3–6 × 2–4 μ. In *R. aquila* (sec. Brefeld) they are 8–10 × 3–4 μ.

Specimens have been examined from many of the States from New England to Washington and south to Florida, Texas and California. Typical specimens from S. C. Teng, Yen-Tsin, Yunnan (No. *1033*) and Jien-mu-shan, Chekiang (No. *1089*), China, are in the Mycological Collections of the Bureau of Plant Industry. The synonymy is as follows:

ROSELLINIA CORTICIUM (Schw.) Sacc. Syll. Fung. **1**: 253. 1882.
Sphaeria byssiseda Schw. Schr. Nat. Ges. Leipzig **1**: 43. 1822. Non Tode.
Sphaeria aquila Schw. Trans. Am. Phil. Soc. II. **4**: 210. 1832. Non Fr.
Sphaeria aquila β corticium Fries, Syst. Myc. **2**: 442. 1823.
Sphaeria purpureo-fusca Schw. Trans. Am. Phil. Soc. II. **4**: 210. 1832.
Sphaeria imposita Schw. Trans. Am. Phil. Soc. II. **4**: 210. 1832.
Rosellinia aquila Am. auct. Non DeNot.
Byssosphaeria imposita (Schw.) Cooke, Grevillea **15**: 122. 1887.
Byssosphaeria corticium (Schw.) Cooke, Grevillea **15**: 122. 1887.
Byssosphaeria purpureo-fusca (Schw.) Cooke, Grevillea **15**: 122. 1887.
Rosellinia imposita (Schw.) Sacc. Syll. Fung. **9**: 496. 1891.

21. SPHAERIA AFFLATA Schw. Schr. Nat. Ges. Leipzig 1: 34. 1822.

Schweinitz' original description was as follows:

68. *afflata* Sz.
S. monosticha tenuissima effusa effigurata nigerrima; ostiolis minutissimis dense punctata.
In lignis siccis.—Tenuissima, effiguratas maculas variae figurae quasi graphicas exhibens, ligno quasi afflata uti mappa geographica effigurata, lignum nullo modo penetrans. Sphaerulae confertissimae minimae in stromate quasi nidulantes.

About the same time Fries (Syst. Myc. 2: 344. 1823) published the following description based upon specimens of Schweinitz' original gathering from North Carolina:

50. *S. afflata,* effusa, tenuissima, effigurata, nigerrima, peritheciis confertissimis minimis prominulis dense punctata.
S. afflata. Schwein! l.c. n. 68.
Omnium hujus seriei tenuissima, maculas atramentosas opacas variae figurae & saepius lobatas exhibens, ligno quasi afflata (nullo modo immersa), uti mappa geographica effigurata. Perithecia minima, superficialia, stipatissima, plane concreta stroma sistunt. *In lignis siccis Carolinae.* (v.s.)

Later Schweinitz (Trans. Am. Phil. Soc. II. 4: 192. 1832) mentions the species as follows:

1203. 57. S. afflata, L.v.S., Syn. Car. 68, F. 50, etiam Bethl.

Schweinitz' original packet labelled "Sphaeria afflata LvS Fr. Sal. & Bethl." is empty. There is a bit of it in the Collins collection of Schweinitz' specimens bearing the same label. This contains two pieces of thick, dead bark looking exactly alike. There is also an autographed specimen from Schweinitz in Brongniart's Herbarium in the Paris Museum labelled, "Car. Sup. Schw. 1824," on the same kind of bark, and identical in appearance with the others. There is also a specimen in Schweinitz' mounted collection at Philadelphia which is identical in appearance. The part of Schweinitz' specimen in the Michener Herbarium consists of a piece of dead bark with the remains of a gummed paper strip, and is probably part of the Salem specimen. This is exactly like all the others examined except in size and outline of the stromata. A thorough microscopic examination of these specimens shows no spores of any kind. The macroscopic appearance of the specimens

is that of a very thin layer of closely packed minute perithecia resembling somewhat *Diatrype stigma* (Hoffm.) DeNot. The specific name evidently refers to the very thin superficial stroma.

We have been on the lookout for specimens of this fungus for many years, but have never seen anything exactly like it until very recently. While examining specimens of *Nummularia* in the Lloyd herbarium, we found two gatherings labelled "*Nummularia* sp.," which in general appearance look exactly like the Schweinitzian specimens we have examined. The only references to this species since Schweinitz' record that we have been able to find are as follows: Curtis (Catalogue of Flora of North Carolina 140. 1867) lists it as *Hypoxylon afflatum* (Schw.). Saccardo (Syll. Fung. **1**: 391. 1882) also refers it to *Hypoxylon,* but with no additional information. Cooke (Grevillea **11**: 128. 1883) has the following note: "1502 *Hypoxylon afflatum* Schw. allied to *Diatrype stigma* with hyaline sporidia." We do not know the source of the specimen in which Cooke found "hyaline sporidia." Saccardo (Syll. Fung. **9**: 477. 1891) on the basis of Cooke's note just mentioned records the species as *Diatrype afflata* (Schw.) Cooke. Ellis and Everhart (N. Am. Pyren. 743. 1892) say "the specimen in Herb. Schweinitz is a mere sterile crust." This species is not mentioned by Starbäck in his account of Schweinitz' species found in Fries' Herbarium.

The two specimens discovered in the Lloyd herbarium labeled *Nummularia* were collected by C. H. Demetrio near Emma, Mo. Demetrio No. *820* (*13059* Lloyd Herb. Cat. No.) on hickory bark, Nov. 1921, agrees entirely with Schweinitz' original specimens, but instead of being sterile shows pycnospores or spermatia. The spores fill the pycnidia in a hyaline gelatinous mass, and are very minute, subelliptical, about $1.5 \times 1\ \mu$. The other specimen is Demetrio No. *817* (*13049* Lloyd Herb. Cat. No.) on bark of dead oak, Jan. 17, 1923. This specimen fortunately shows good perithecia with mature asci and ascospores, which agree most nearly with the genus *Melanomma* as typified by *M. pulvis-pyrius* (Pers.) Fuckel. As we have found no fungus agreeing with this described under this or other related genera, we designate the species **Melanomma afflatum** (Schw.) Shear, comb. nov., with the following description:

Stromata very thin, effuse, irregular in outline, 1/4 to 1/2 mm. thick; perithecia small, very densely arranged, carbonaceous, globose; ostioles small, slightly prominent becoming umbilicate; asci elongate-clavate, subsessile, $65–75 \times 12–16\ \mu$; ascospores subbiseriate, oblong elliptical, somewhat inequilateral, 3-septate, somewhat constricted at the middle, upper half somewhat larger, dark brown, $15–18 \times 8–9\ \mu$; paraphyses filiform, entangled or anstomosing, exceeding the asci.

Habitat. Surface of smooth, dead, old oak and hickory bark.

22. DOTHIDEOVALSA TURNERAE (Tassi) Shear

This name proposed in the author's Mycological Notes III (Mycologia **31**: 336. 1939) should be changed to **Dothideovalsa eutypoides** (Ellis & Ev.) comb. nov. inasmuch as the specific name *eutypoides* has priority over *turnerae* (1899), it having been published as *Bagnisiella eutypoides* Ellis & Ev. Jour. Inst. Jamaica **1**: 382. 1893. This citation is not included in Farlow's list of the works of J. B. Ellis and hence was overlooked, the name having been regarded as an herbarium name only.

BUREAU OF PLANT INDUSTRY,
WASHINGTON, D. C.

NOTES AND BRIEF ARTICLES

Boletus brevipes Peck in Southern California

This fungus has been collected in abundance in a planting of pines at the Citrus Experiment Station. *Boletus brevipes* is not listed by McClatchie in Seedless Plants of Southern California. Dr. Lee Bonar, of the University of California, reports in a personal letter that this species has been collected only a few times in the mountainous area of California. Its development has doubtless been favored by the continuous and (for southern California) heavy rains of the month of February, 4.65 inches distributed in Riverside on 12 different days.—Clayton O. Smith.

Pyrenomycete Note

1. **Mycosphaerella nigrita** (Cooke) Miller, comb. nov.

Sphaerella nigrita Cooke, Grevillea **7**: 13. 1878.

The perithecia are congested in orbicular spots, semi-erumpent, with elongate elliptic, uniseptate, hyaline ascospores, $15 \times 4\ \mu$.

On oak leaves in New York, sent to Cooke by Gerard. This species also occurs in Georgia on *Quercus lyrata* Walt.

There are two other species on oak leaves in Georgia. *Mycosphaerella spleniata* (Cooke & Peck) House occupies large areas on the leaf and the perithecia are also congested, but differs macroscopically in possessing smaller perithecia almost completely sunken in the leaf. Then *Mycosphaerella maculiformis* (Pers. ex Fries) Schroet. differs in occurring in very small, angular spots only a few millimeters in diameter, and apparently never spreads out over large areas of the leaf as the other two species.

There is a later *Sphaerella nigrita* Roum. in Fungi Gall. no. *1606,* 1879–1898. This name would have no validity because of the date and also because of the lack of a formal published description.—Julian H. Miller.

MYCOLOGICAL SOCIETY OF AMERICA

SUMMER FORAY

The 1941 Foray will be held at Macdonald College, August 25–28 inclusive, with the Department of Plant Pathology at Macdonald College and the Department of Botany at McGill University as hosts. Headquarters will be in the Department of Plant Pathology in the Biology building.

Macdonald College is located in the town of Ste. Anne de Bellevue on the western tip of Montreal Island at the confluence of the Ottawa and St. Lawrence Rivers some 20 miles west of Montreal.

Those coming eastward from Toronto or Ottawa will cross two large bridges over the Ottawa River (the second a toll bridge) into the town of Ste. Anne de Bellevue. Macdonald College is about ½ mile east. Both Route 2 and the new 4-lane highway, as yet unnumbered, pass through the College, which can be recognized by its brick buildings with red tile roofs.

Those approaching from the south and east should come via Montreal. Cross a toll bridge over the St. Lawrence River, turn westward and follow the Toronto-Ottawa highway, Route 2, or the new 4-lane highway for about 20 miles. Do not cross a second toll bridge.

Accommodations will be furnished in the dormitories and dining room of the College at the rate of $2.50 a day a person, 2 in a room, or $4.00 a day a person, single room. Those who plan to take advantage of the College facilities should notify Dr. Ivan H. Crowell by August 20th, if possible—post office address Macdonald College, Quebec; telegraph address, Ste. Anne de Bellevue, Quebec.

The general terrain of Macdonald College is largely flat hardwood and farm land, entirely different from the hilly coniferous forests found at Duchesnay where the 1938 Foray was held. From the College one can see the low foothills of the Laurentian Mountains which contain mixed hardwoods and conifers. A little farther north are pure coniferous stands with numerous ponds and swamps. Trips to some of these Laurentian areas will be planned for the Foray.

For the entertainment of wives, children and friends, golf, tennis, swimming, boating, picnicking, hiking and library facilities will be available, not to mention shopping and sight-seeing trips to near-by Montreal.—WALTER H. SNELL, VICE PRESIDENT.

A TWEEZERS METHOD FOR MAKING MICROSCOPIC SECTIONS OF PLANT PATHOLOGICAL MATERIAL [1]

(WITH 6 FIGURES)

The type of tweezers found to be most satisfactory for the purpose of making microscopic sections was a small pair about 3″ long with either straight or curved ends such as is generally used in laboratories. It is essential that the tips of these tweezers be of the same length and sharpened to a knife-like edge as shown in the line drawing. This can readily be done with the aid of a small hone. The advantages in having the tweezers sharpened in this manner is that their tips meet with exactness and they can do some cutting (FIG. 6).

The basic technique of the method is that of stripping plant tissues. The procedure has long been followed, as for example, in stripping the epidermis for the purpose of studying stomata, or examining teliospores of certain rusts which form in epidermal cells. The writer wishes to call attention to certain other possibilities. Interesting mounts of several species of parasitic Phycomycetes have been prepared by the stripping method. By cutting through the infected epidermis with the tweezers, gently stripping a portion off and mounting it with a minimum of disturbance in such media as lacto-phenol or glycerine jelly, mounts may be obtained similar to the one shown in figure 1. In such mounts conidiophores can be seen protruding through stomata, in various stages of development and with some spores still attached.

Quite a different type of mount is shown in figures 2 and 3. Fine hair-like strands are readily stripped longitudinally from

[1] Contribution from the Faculty of Agriculture, McGill University, Macdonald College, Que. Macdonald College Journal Series No. 152.

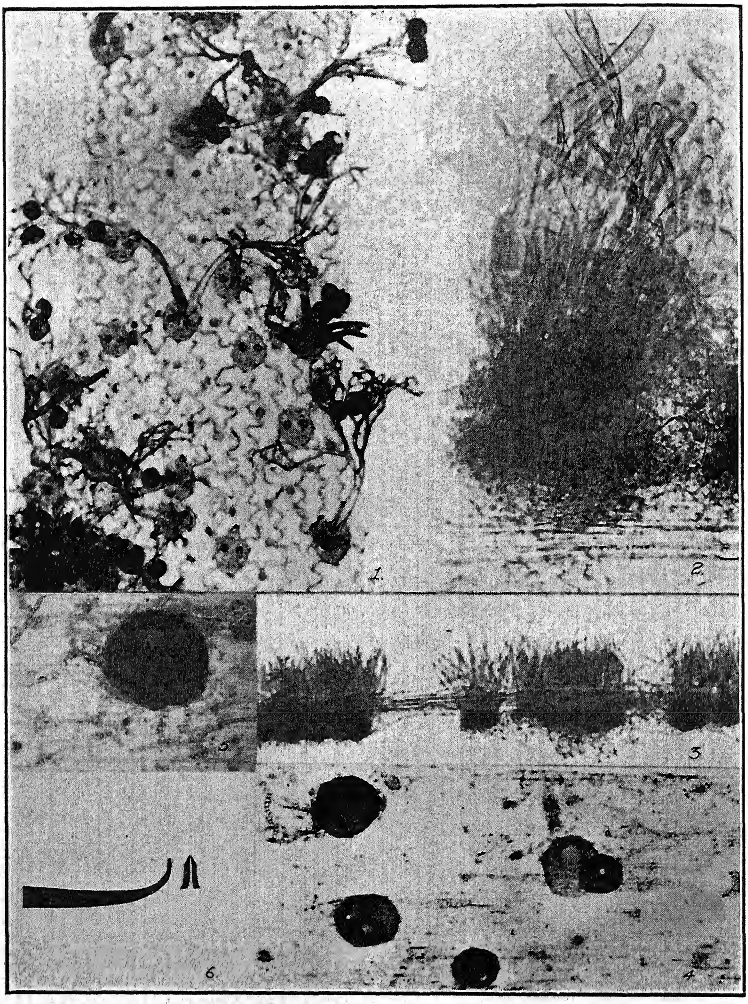


FIG. 1, Fruiting structures of *Peronospora corydalis* are shown in various stages of maturity protruding through stomata on a leaf of *Dicentra cucullaria;* 2, an enlarged fruiting stroma of *Scolecotrichum graminis;* 3, several fruiting stromata of *S. graminis* are shown in relation to the host tissue; 4, *Phoma herbarum*, a general view of pycnidia and mycelium on the epidermis of a petiole of rhubarb; 5, an enlarged pycnidium and some of its supporting mycelium; 6, tweezers to be used for making microscopic sections should be sharpened as shown.

leaves of grasses or other monocotyledonous plants. The plane of stripping is at right angles to the surface. The section illustrated shows in original relationship the completely submerged stromata with conidiophores and several conidia attached. Similar mounts have been prepared showing conidiophores emerging singly or in small non-stromatic groups, often with much detail of the internal mycelium from which they arose.

In figure 4 is shown a similarly made preparation of an imperfect fungus in which the pycnidia and mycelium are mounted whole and in their original relationship with the host epidermis. Greater details are shown of a single pycnidium and part of its mycelium in figure 5.—IVAN H. CROWELL.[2]

REPRINTS AND BOOKS FOR CHINA

I have been asked by the West China Institute of Applied Biology, West China Union University and the Division of Mycology and Plant Pathology, Chinese National Tea Station, National Bureau of Agricultural Research to collect reprints of articles and books pertaining to phytopathology and mycology.

These institutions have never had an adequate number of periodicals and books in these fields. Now, because of the conditions brought on by the war, they have lost some of the material formerly possessed.

I earnestly hope that mycologists and phytopathologists in America who have such reprints of articles or books will be so kind as to contribute to these institutions. It will be of extreme value to the Chinese educational program as well as the advancement of biological sciences and the faculty of these institutions will be everlastingly grateful to you.

These materials may be sent directly to me and I will see that they get into China. Be assured they will be most gratefully received.—WEN-CHUN HO, Department of Botany, Iowa State College, Ames, Iowa.

[2] Lecturer in Plant Pathology, Macdonald College, Que.

REVISED DESCRIPTIONS OF THE GENERA ELSINOË AND SPHACELOMA

In connection with a monograph on *Elsinoë* and *Sphaceloma* it has seemed desirable to present beforehand revised descriptions of these myriangiaceous genera:

ELSINOË Racib. Emend. Par. Algen Pilze Java's **1**: 14. 1900.
Plectodiscella Woronichin, Myc. Centralb. **4**: 232. 1914.
Isotexis H. Sydow, Ann. Myc. **29**: 261. 1931.

Fertile stromata embedded in the host tissues, scant or effuse, consisting of more or less well defined masses of tissue or composed of hyaline or pale yellowish pseudoparenchymata, changing internally into a more or less loose prosenchyma and thus gradually intermingling with the diseased host tissue, sometimes confined to outer portion of host tissues, frequently originating in or just below the disrupted epidermis and becoming erumpent and well defined only on the exterior portion, there often covered with a dark layer, sometimes referred to as the epithecium, of variable thickness, occasionally linear and branched, following the leaf veins; asci few to numerous, irregularly imbedded in the stroma, and where stroma is scanty, apparently developed almost directly in host tissues, globose to piriform, double-walled, with outer wall thin and inelastic and inner wall thickened especially at the apical region and provided with a more or less well developed foveola, expanding upon rupture of outer wall, containing 1 to usually 8 spores; ascospores hyaline, typically 3 septate, more rarely 4–5 septate, sometimes with a longitudinal or diagonal septum in one or more cells, the two upper cells often broader and shorter than the lower ones, usually germinating by sprout conidia, but may produce germ tubes, one from each cell.

Conidial stage, *Sphaceloma*.

Type species, *Elsinoë Canavaliae* Racib., causing scab of *Canavalia gladiata* (Jacq.) DC.

Strictly pathogenic, producing destructive anthracnoses of plants of many families, from the Pteridophyta to the Compositae, lesions small, necrotic or hyperplastic, often numerous or coalesced, and on leaves attacking veins and petioles as well as non-vascular areas; gumming of tissues occurring beneath host cells first invaded, which become killed and desiccated; in hyperplastic lesions, on leaves as well as other parts, a definite generating layer being formed, which

gives rise to the hyperplastic tissue forming the excrescences often called scabs, *e.g.*, those of scab of sour orange caused by *Elsinoë Fawcetti*.

SPHACELOMA DeBary, Emend. Ann. Oenol. **4**: 165–167. 1874.

Manginia Vial. & Pacot.[1] Compt. Rend. Acad. Sci. Paris **139**: 88. 1904.

Melanobasidium Maubl. (*Melanobasis* of Clements & Shear, Genera of fungi 370. 1931.) Bull. Soc. Myc. Fr. **22**: 64. 1906.

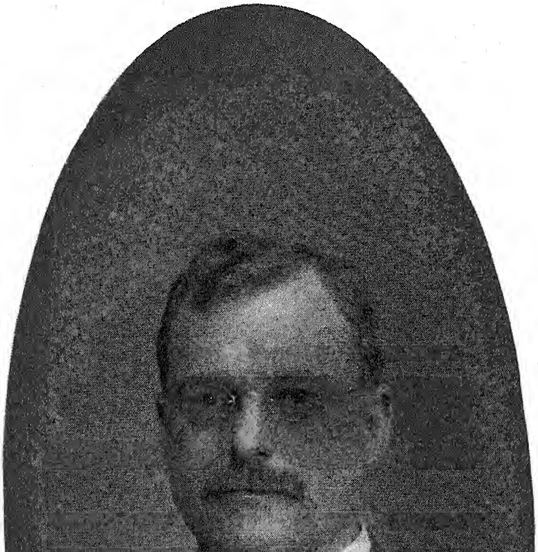
Hyphae subcuticular or more often intraepidermal, composed of strands of more or less well developed hyaline or yellowish pseudoparenchyma, supporting clusters of densely crowded, short conidiophores, often assembled in conical, protruding bundles, or forming a continuous superficial layer or palisade, but sometimes depressed into a typical acervulus, the pseudoparenchyma and overlying conidial layer also sometimes constituting sporodochial masses, hyaline at the base, generally darkening towards the outer surface, scattered or coalescing into a continuous pseudoparenchymatic stroma, bearing on the surface a layer of usually dark closely appressed cells, the palisade of conidiophores; conidiophores usually short, cylindrical, pointed at apex, or broad at base, narrowing to a point, often unicellular or 1-septate, more or less the length of the conidia, occasionally longer, practically flexuous, several septate, at times branched and geniculate at the insertion of conidia, forming bundles or a uniform covering of velvety appearance over the lesion; producing conidia acrogenously or pleurogenously, from one to several in succession from the same point sometimes shortly catenulate; conidia hyaline, continuous, small, refringent, ovoid to oblong-elliptical, often having at either end a shining guttula, with mucilaginous wall, occasionally elongate to cylindrical, with one to several septa, yellowish or dark; minute refringent, bacterium-like bodies, with a thick gelatinous wall, provisionally called microconidia, also formed. Pycnidia or pycnidia-like bodies sometimes formed, *e.g.*, in *Elsinoë Randii;* microconidia more or less constantly in evidence, sometimes filling

[1] These authors substituted the name *Manginia* for *Sphaceloma* upon obtaining, in what they supposed were pure cultures of *S. ampelinum* DeBary, forms which they describe as spermagonial, pycnidial, yeast, etc. From their account of these cultures it is apparent that they were in part if not entirely impure. The name *Manginia,* therefore, refers only in part to the genus *Sphaceloma*.

host cells; conidial fructifications sometimes indistinct or practically lacking or conidiophores present and conidia not in evidence, these being produced promptly, however, under favorable conditions and germinating by sprout conidia or by germ tubes, sometimes becoming greatly swollen and muriform, young as well as old hyphae capable of conidial production. *Sphaceloma* as well as *Elsinoë*, producing a slow compact, often colorful, gummy growth on most agar media.

Type species, *Sphaceloma ampelinum,* causing anthracnose of grape (*Vitis*). Ann. Oenol. **4**: 165–167. 1874.

Hosts, as for the genus *Elsinoë*.—A. E. JENKINS AND A. A. BITANCOURT.



HOWARD JAMES BANKER.

MYCOLOGIA

OFFICIAL ORGAN OF THE MYCOLOGICAL SOCIETY OF AMERICA

VOL. XXXIII JULY–AUGUST, 1941 No. 4

HOWARD JAMES BANKER (1866–1940)

JOHN HENDLEY BARNHART

(WITH PORTRAIT)

Howard J. Banker was born at Schaghticoke, Rensselaer County, New York, 19 April 1866. He was a son of Amos Bryan Banker and Frances Alcena Welling his wife, and was a descendant in the 7th generation of Laurens Mattyse Bancker, an early Dutch settler in the colony of New York.

After his graduation from Syracuse University in 1892, he taught for three years at the Troy Conference Academy, at Poultney, Vermont. While here he prepared himself for the Methodist ministry. It was during this period that he married, 23 August 1894, Mary Eugenia Wright, who was his companion for the remainder of his life (46 years).

He served in only one pastorate, Union Church at Proctor, Vermont, from 1895 to 1898; then he entered upon graduate work at Columbia University, receiving the degree of A.M. in 1901. It was while at Columbia that he commenced the studies of Hydnaceae with which his name is usually associated in the minds of mycologists. The following year he was a teacher at Dickinson Seminary; his department was mathematics, but his first mycological paper was published in 1901, and was dated at Dickinson. After three years as teacher of biology at the Southwestern State Normal School at California, Pennsylvania, he spent ten years, 1904 to 1914, as professor of biology at DePauw University. In 1906 he received the degree of Ph.D. from Columbia.

[MYCOLOGIA for May–June (33: 241–340) was issued June 1, 1941]

The years 1901 to 1914, about one fourth of his mature life, covered nearly all of his active work in botany. Of his 18 botanical papers, all in the field of mycology, 16 appeared during this period; the longest was "A contribution to a revision of the North American Hydnaceae" (1906), constituting the second number of the 12th volume of the Memoirs of the Torrey Botanical Club. This discussed 62 pileate species distributed in ten genera. He was one of the associate editors of Mycologia from its establishment in 1909 until it became the organ of the new Mycological Society of America in 1933, and to its pages he contributed several papers, including a series of seven under the general title "Type species in the Hydnaceae" (1912–14). This series was based upon the examination of specimens in various European herbaria, including those of Kew, the British Museum (Natural History), Paris, Berlin, Upsala, and Leiden, during the summer of 1910. At his request, Mrs. Banker is presenting his herbarium to the New York Botanical Garden.

In 1914 he joined the staff of the Eugenics Record Office of the Station for Experimental Evolution maintained by the Carnegie Institution of Washington at Cold Spring Harbor, Long Island, and here he remained until his retirement in 1933. His work was chiefly in the field of human genetics, and this fitted very nicely into his lifelong interest in genealogy. He had published a Bancker genealogy in 1909, and in 1913 had completed and edited the Underwood genealogy that was left in manuscript by his botanical preceptor and honored friend, Professor L. M. Underwood of Columbia University. Few genealogists have ever attempted to record causes of deaths, and fewer still have systematically enumerated physical traits such as height, weight, hair-color, and eye-color, or mental traits such as temperament, memory, and talent; yet they have usually told enough about the members of a family to provide a light framework for genetic studies and to suggest promising fields for further investigation. Banker's later studies in genealogy were primarily in the field of aristogenic human heredity.

As an undergraduate he became a member of the Delta Upsilon fraternity, and later (1902) was elected to the honorary fraternity Phi Beta Kappa. He joined the Torrey Botanical Club in 1900,

and was an original member of the reorganized and expanded Botanical Society of America in 1909, but he eventually resigned from both, the latter in 1927, the former in 1933. He became a member of the American Association for the Advancement of Science in 1902, a fellow in 1905, and a life fellow in 1923. While at DePauw he was affiliated with the Indiana Academy of Science.

He died at his home in Huntington, New York, 13 November 1940. The accompanying portrait shows him as he was during his professorship at DePauw University, which was also the period of his greatest botanical activity; he was then about 40 or 45 years old. Another excellent portrait, dating from the same period, forms the frontispiece of his Bancker genealogy, already mentioned.

His scholarship is manifest in his published work. His personality was of an unusually pleasing type. His modesty was almost excessive. His friendships were firm and enduring. The passing of such a man leaves wounds that only time can heal.

His published botanical papers were as follows:

A preliminary contribution to a knowledge of the Hydnaceae. Bull. Torrey Club **28**: 199–222. 18 Ap. 1901.

A historical review of the proposed genera of the Hydnaceae. Bull. Torrey Club **29**: 436–448. 25 Jl. 1902.

Observations on *Phallus Ravenelii.* Torreya **4**: 5–8. 27 Ja. 1904.

Notes on the variability of *Hypothele repanda.* Torreya **4**: 113–117. 27 Au. 1904.

A contribution to a revision of the North American Hydnaceae. Mem. Torrey Club **12**: 99–194. 13 Je. 1906.

A new fungus of the swamp cedar. Bull. Torrey Club **36**: 341–343. *pl. 24.* 17 Je. 1909.

A correction in nomenclature. Mycologia **2**: 7–11. 1 Ja. 1910.

Steccherinum septentrionale (Fr.) Banker in Indiana. Proc. Ind. Acad. **1910**: 213–218. *illust.* 1911.

Type studies in the Hydnaceae—I. The genus *Manina.* Mycologia **4**: 271–278. 28 Au. 1912; —II. The genus *Steccherinum.* Mycologia **4**: 309–318. 23 N. 1912; —III. The genus *Sarcodon.* Mycologia **5**: 12–17. 13 Ja. 1913; —IV. The genus *Phellodon.* Mycologia **5**: 62–66. 10 Mr. 1913; —V. The genus *Hydnellum.* Mycologia **5**: 194–205. 10 Jl. 1913; —VI. The genera *Creolophus, Echinodontium, Gloiodon,* and *Hydnodon.* Mycologia **5**: 293–298. 25 N. 1913; —VII. The genera *Asterodon* and *Hydnochaete.* Mycologia **6**: 231–234. 26 S. 1914.

An instructive modification of an old experiment. Proc. Ind. Acad. **1912**: 93, 94. *illust.* 1913.

Notes on Florida fungi. Mycologia **19**: 39–42. 1 Ja. 1927.

Notes on the Hydnaceae. Mycologia **21**: 145–150. 1 My. 1929.

A FUNGOUS DISEASE OF CODLING MOTH LARVAE

Vera K. Charles

(with 1 figure)

In April of the past year specimens of codling moth larvae (*Carpocapsa pomonella* L.) apparently killed by a fungus, were referred to the Division of Mycology and Disease Survey by Dr. W. S. Hough, of the Winchester Research Laboratory, of the Virginia Agricultural Experiment Station. At this time also Mr. Dickinson, entomologist for the Sherwin-Williams Company, reported that about 10 per cent of the larvae in an apple orchard at Berryville, Va., had been stricken with the disease. An inspection of the orchard by the writer two weeks later showed the per cent of larvae attacked to be much higher than originally estimated, possibly 40 per cent of the larvae being killed. Mr. Dickinson's continued observation of the orchard led him to confirm this estimate of the higher per cent of control exerted by the fungus.

Two other occurrences of this fungus on the larvae of codling moths have been observed by the writer, one collection from Vincennes, Indiana, received from Dr. Alvah Peterson in 1927, and a second collection from Delaware submitted by Mr. Floyd S. Zimmerman in 1930. According to Mr. Zimmerman the fungus appeared to be doing effective work in reducing the numbers of overwintering codling moths on the apple trees.

GROSS APPEARANCE

The dead larvae were hard and in many instances covered with white to grayish mycelium which on examination was found to be fruiting, though sparingly. In addition to this type of fructification, slender, brownish clavae (fig. 1) were present in about 20 per cent of the specimens collected in the Virginia orchard. The clavae consisted of closely packed, parallel hyphae bearing the same type of fruiting bodies as the loose mycelium on the exterior

of the bodies of the dead larvae. The latter were hard and filled with coarse mycelium consisting of numerous short segments.

THE FUNGUS IN CULTURE

The fungus grew readily from the mycelium within the hardened bodies of the larvae and fruited within 10 days but did not produce clavae. However, the latter developed abundantly on the bodies of the dead larvae after being kept at a cool temperature for about 10 days. The organism grew well on cornmeal agar and Thaxter's potato dextrose, but slowly on Molisch's agar. A very active species of *Fusarium* frequently overgrew young cultures, sometimes wholly obliterating them, but it never appeared to be the primary parasite.

IDENTITY OF THE FUNGUS

A comparative study of the fungus on the exterior of the codling moth larvae and of the cultures grown from the mycelium filling the body cavity, showed the two organisms to be identical. In one instance, two immature perithecia were found on a clava, but no other development of an ascogenous stage was observed. Until there is an opportunity to study mature specimens of the perfect stage, the fungus must be referred to the form genus *Hirsutella,* established by Patouillard (2) in 1892 for a fungus on a coleopterous insect from Brazil. The genus *Hirsutella* is characterized by slender, erect clavae from which phialides arise. The latter have an inflated base and one or occasionally two long thread-like sterigmata, each bearing a single apical conidium. The conidia are surrounded by a gelatinous substance which causes them to adhere in clusters. Patouillard regarded the fungus as a Basidiomycete and referred it to the Clavariae. In 1912 Speare (9) discussed and figured a fungus parasitic on *Perkinsiella saccharicida* in Hawaii which he considered a sterile *Cordyceps.* Later he (8) had an opportunity to consult literature and study other material and as a result was able definitely to determine his fungus as a *Hirsutella.* In addition he recognized the true taxonomic position of the genus *Hirsutella* referring it to the Stilbaceae of the Fungi Imperfecti. Petch accepted Speare's allocation of the genus and

in 1932 (4) reduced his genus *Trichosterigma* (3) to synonymy with *Hirsutella* Pat. At this time Petch stated that no ascigerous stage had been previously recorded for any species of *Hirsutella,* but that during an examination of a collection of Ceylon species of *Cordyceps* he found that *C. unilateralis* had a *Hirsutella* conidial stage, the apex of the clava being at first conidial. Since this date several species of *Hirsutella* have been found to be the conidial stages of species of *Cordyceps.*

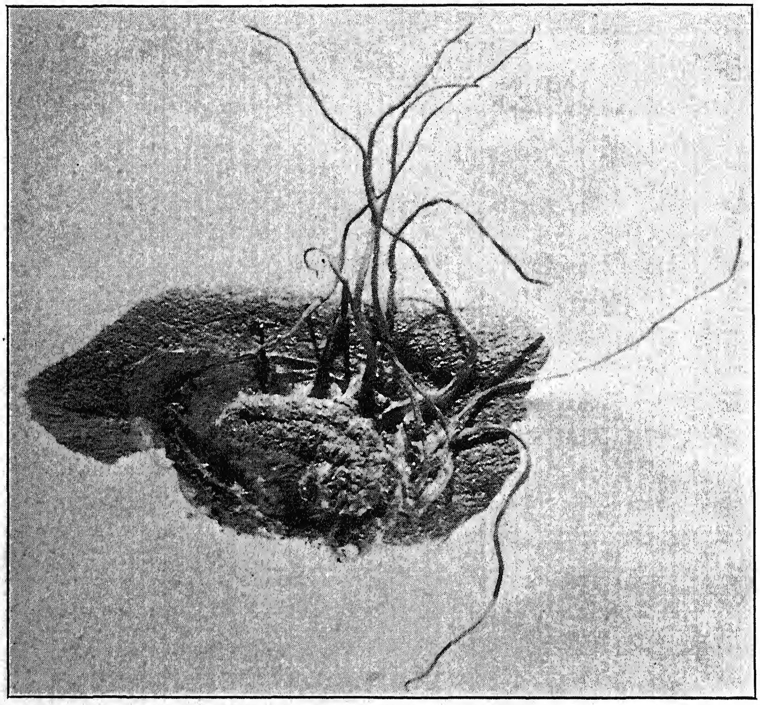


FIG. 1. Codling moth larva showing development of clavae of *Hirsutella subulata* Petch.

In 1932 Petch (4) described *H. subulata* on an undetermined caterpillar collected at Milton, Northamptonshire, England, and recorded by Berkeley and Broome as *Isaria floccosa* Fries. This specimen is now in the Kew Herbarium. Some doubt seems to exist as to the common identity of these two fungi, *I. floccosa* Fries and *H. subulata,* but Petch remarked that the combination *H. floc-*

cosa Fries is preoccupied by Speare's use of the binomial (8, p. 69), therefore the English species may be named *H. subulata* without considering its possible identity with *Isaria floccosa* Fries. Fries' type specimen was recorded on *Bombyx jacobae* (*Lepidoptera*), cinnabar moth, but the description (1, p. 274) is very brief and unsatisfactory. This species may be a *Hirsutella* as Petch inferred, but because of the absence of the type specimen for examination no definite decision can be reached. The uncertainty of this reference is further increased by Fries' statement that *I. floccosa* is related to *I. arachnophila* Ditm., which fungus Petch's investigations have shown to belong to *Hymenostilbe* (5), a genus established by him in 1931. A second English record of *I. floccosa* was made in Yorkshire on a dead grub which had crept inside a perforated empty shell of a hazel nut at Masham, 1901. According to Petch (l.c.) this specimen was not available for examination.

In 1937 (6) Petch discussed two North American specimens of *H. subulata* from the Farlow Herbarium. One specimen (Farlow Herb. *4*) was on the larva of *Aegeria Pyri* Harris in apple bark, collected by J. L. Zabriskie, Flatbush, Long Island, New York. The fungus was described as having 3 clavae, with the bases of 4 or more others present. These were linear, terete up to 1.5 cm. high and 0.3 mm. in diameter. The measurements of the conidia were given as $4\text{–}6 \times 1.5\text{–}2\ \mu$, the conidial cluster was oval and about $8 \times 5\ \mu$. The second specimen collected by C. O. Riley at Washington, D. C. (Farlow Herb. *6241*) was recorded as on the larva of a codling moth under a piece of bark.

Until the ascogenous stage of the fungus is known, it would seem best to refer the American species of *Hirsutella* on codling moth larvae to *Hirsutella subulata* Petch, although certain differences are to be noted, such as the occasional bifurcate clavae and 2-sterigmate phialides. The latter character was given in Patouillard's original description of the genus, but Petch first described the basidia or phialides as termed by him as bearing a single sterigma. However, he later referred the conidial stage of *Cordyceps clavulata* to the genus *Hirsutella,* calling it *H. lecanicola* (Jaap) Petch regardless of the fact that Pettit (7) described and figured it with simple or branched sterigmata. *Hirsutella nodulosa* Petch is also illustrated as having more than one sterigma, but is de-

scribed by Petch as being abnormal. The author's observation and study of the species of *Hirsutella* on many different insect hosts would indicate that this is not a generic character.

While the measurements of the phialides, sterigmata and conidia in the American form exceed those given for *H. subulata* Petch, the differences would not seem to justify describing a new species, especially since the measurements of the conidia given by Petch for the Farlow specimens (phialides and sterigmata not described) exceed the measurements which he gave in his diagnosis of *H. subulata*.

The following table is given to permit of a direct comparison of the measurements of the English and American specimens. The measurements of the English material are those given in the description of *Hirsutella subulata* Petch (**6**).

COMPARATIVE MEASUREMENTS OF SPECIMENS OF *Hirsutella subulata* PETCH

Source	Phialides	Sterigmata	Conidia
England	$4 \times 5\ \mu$	5–8 μ	$1 \times 2.5\ \mu$
Virginia	6–10	8–10	$2–2.5 \times 5–6$
New York (L. I.)	Not given	Not given	$1.5–2 \times 4–6$
Dist. of Col.	Not given	Not given	1.5×4

In view of the data here presented, and in the absence of a mature ascogenous stage, the American species of *Hirsutella* on codling moths may be definitely determined as *Hirsutella subulata* Petch.

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STUDIES IN THE GASTEROMYCETES III. THE FAMILY, ARACHNIACEAE

W. H. Long

(with 7 figures)

This paper gives an emended description of the family Arachniaceae, and of the genus, *Arachnion,* describes a new genus and species, *Araneosa columellata,* gives keys to the genera and species now included in the family and discusses briefly *Arachniopsis albicans.*

Arachnion album was originally described by Schweinitz[1] in 1822 from material collected in North Carolina. Other species have since been added, but only *A. album* has been considered in the family and generic descriptions, although some of the foreign species have other characters that should be included. It therefore seems wise to emend the diagnoses so as to include all of the characters now known to belong to this family.

Arachniaceae.

Sporophore epigeous or hypogeous, sessile or stipitate, with or without sterile base; *peridium* single or double, dehiscent or indehiscent; *columella* present or absent; *gleba* of distinct chambers lined by the hymenium, these chambers forming at maturity a mass of minute separate, hollow, peridioles which contain the spores; *capillitium* none; *spores* continuous.

Key to the Genera

Sporocarp sessile, columella absent .... *Arachnion.*
Sporocarp stipitate, columella present .... *Araneosa.*

Tentative Key to the Species of Arachnion

1. Sporophore hypogeous 2
1. Sporophore epigeous 3
2. Sporocarp dehiscing by an apical lacerate stoma .... *A. rufum.*
2. Sporocarp dehiscing irregularly, gleba yellow .... *A. Drummondii.*
3. Peridium single, without sterile base 4

[1] Schweinitz, L. D. von. Syn. Fung. Carol. 59, *pl. 1, fig. 2.* 1822.

3. Peridium double, with sterile base .... *A. scleroderma.*
4. Gleba brown .... *A. bovista.*
4. Gleba gray or ash gray 5
5. Spores apedicellate 6
5. Spores pedicellate, threads of peridioles not coloured .... *A. tener.*
6. Sporocarp white, small .... *A. album.*
6. Sporocarp large, dark fuligineous .... *A. giganteum.*

A discussion of the species of *Arachnion* will appear in a later paper.

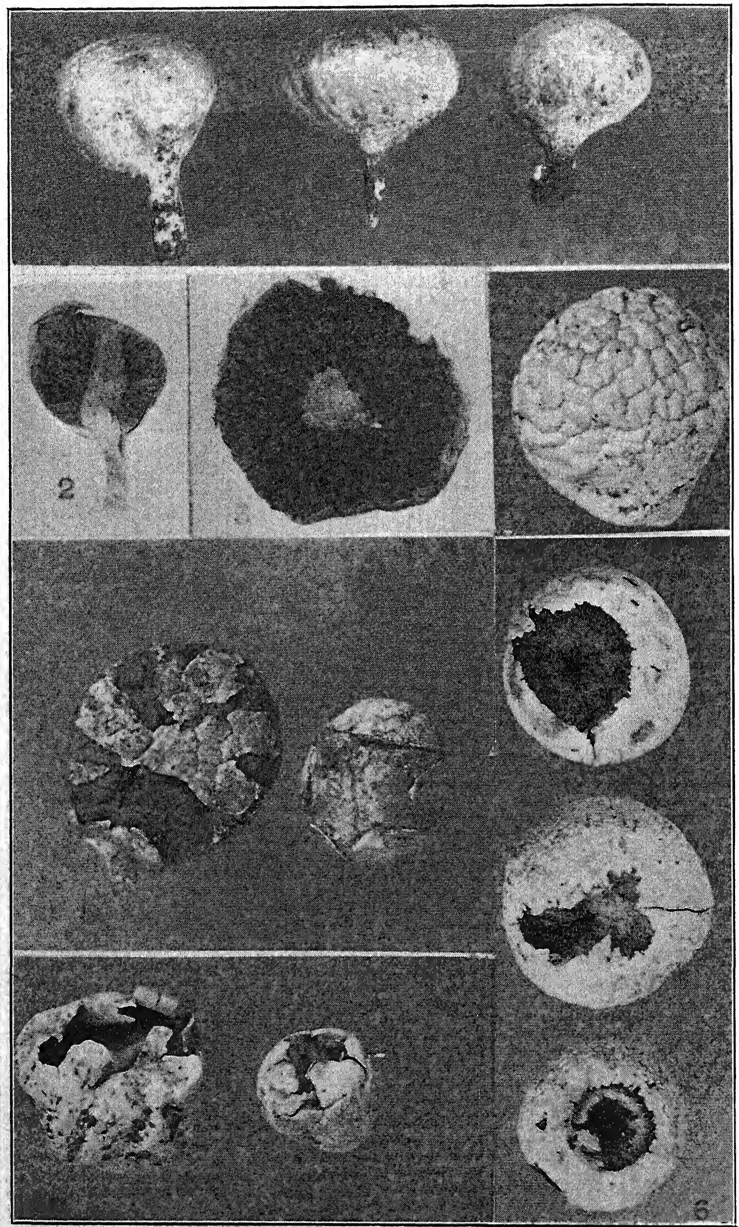
Araneosa gen. nov.

Sporophore epigeous, stipitate, sterile base none; *peridium* of two layers, an exoperidium and an endoperidium; *exoperidium* membranous; *endoperidium* semi-gelatinous to sub-fleshy when young; *dehiscence* by a single, basal orifice; *stipe* central or sub-eccentric (FIG. 1, 2), short, continuing as a columella to apex of the sporocarp (FIG. 2); *columella* prominent (FIG. 3, × section view), persistent, free throughout from gleba; *gleba* a mass of granules or peridioles; *peridioles* irregular in shape and size; *spores* smooth.

Sporophora epigaea, stipitata; *peridium* duplex; *stipes* centralis vel sub-excentricus, ad apicem peridii continuus et *columellam* prominentem, persistentem formans; *gleba* initio cellulosa, maturitate peridiolis numerosis appressis (nec connexis) polysporis praedita, basi sterili destituta; *capillitium* nullum.

Araneosa columellata sp. nov.

Sporocarp subglobose to depressed-globose (FIG. 1), 2–3.5 cm. in diameter by 1–2.5 cm. high, occasionally with a partial partition in the gleba but not sufficient to divide the spore sac into complete compartments; *exoperidium* white, often becoming light buff with age, rarely tan, smooth or usually strongly rugose (FIG. 4), giving the surface a wart-like appearance, persistent but often flaking away partially under weathering (FIG. 5); *endoperidium* semi-gelatinous when young becoming thin and brittle at maturity, brown to reddish-brown where exposed (FIG. 5), reddish-brown to terra cotta on inner surface next to gleba; *stoma* a basal orifice left by the caducous stipe (FIG. 6), becoming large and lacerate by cracks radiating from it, which often cause the entire sporocarp to split into spreading segments; *stipe* solid, 7–10 mm. high by 2–7 mm. thick, usually enlarged at the top, soft, spongy, very loosely attached at maturity to base of spore sac by a delicate, yellowish, arachnoid membrane which easily ruptures, thereby



FIGS. 1–6, *Araneosa columellata*, × 1; 7, *Arachniopsis albicans*, × 1⅔.

freeing the stipe so that winds and rains readily separate it from the sporocarp; so loosely are the stipes attached that over 50 per cent of the specimens when collected had lost their stipes and were just little balls rolling around on the ground, even in the herbarium the stipes separate easily from the spore sacs unless very carefully handled; *columella* arachnoid to cottony in texture, having a delicate, very loose, hyaline tissue of thin, flaccid, branching hyphae of varying thickness, traversed lengthwise by yellowish, solid, terete, very long, non-septate, sparingly branched hyphae, 3–7 microns in diameter, firmly attached to the inner wall of the endoperidium at apex, light yellow to pale tan, 5–7 mm. thick at base where joined to the stipe, terete, often attenuate, flattened and denser toward apex, frequently eccentric in the sporocarp (FIG. 2), lower two-thirds usually deciduous with the stipe leaving a conical cavity through which the peridioles escape; *gleba* yellowish to cream color when young becoming mouse gray to neutral gray at maturity, consisting of peridioles arranged in a somewhat lamellate manner (FIG. 2); *peridioles* subglobose to irregularly oblong to angular, walls rather thick and firm, 90–268 microns by 134–402 microns, held loosely together by delicate interwoven hyphae, easily separable from the endoperidium, leaving its inner surface reticulate, the lamelliform arrangement of the peridioles often permitting the gleba to split into flakes which easily crumble into the individual peridioles; *spores* oval, 4.2–6 by 5.6–7 microns, 1-guttulate, many semi-opaque, pedicellate; *pedicels* 2–4 microns long, subhyaline to hyaline, fragile; *epispore* chestnut brown, smooth.

Sporocarpium subglobosum vel depresso-globosum, 2–3.5 cm. latum, 1–2.5 cm. altum; *exoperidio* albido, rugoso; *endoperidio* tenuissimo, glabro, brunneo, cavitate basali dehiscente; *ore* ex irregulari elliptico; *gleba* flavida demum grisea; *peridiolis* friabilibus, irregulariter globosis vel angulosis; *sporis* brunneo-nigris, ellipticis, levibus, 4–6 × 5–7 micra, uniguttulatis, pedicellatis.

HABITAT: Solitary on the ground in open grassy areas in Mesquite-Catclaw flats (Prosopis-Acacia).

DISTRIBUTION: Arizona, Santa Cruz County, 6–8 miles from Nogales on State Highway 89, elev. 3857 ft., *W. H. Long & Victor O. Sandberg,* Nov. 23, 1933, *10 plants* no. *7935;* Feb. 19, 1934, *7 plants* no. *7945;* Sept. 21, 1934, *175 plants* no. *7937 Type;* Nov. 13, 1936, *18 plants* no. *7941; W. H. Long,* Sept. 30, 1939, *62 plants* no. *8388.* Pima County, 8 miles from Tucson on road to Sabino Canyon, elev. 2400 ft., *W. H. Long & Victor O. Sandberg,* Sept. 22, 1934, *4 plants* no. *7993* & *22 plants* no. *8018; W. H.*

Long, Nov. 10, 1938, *1 plant* no. *8289;* Sept. *29,* 1939, *6 plants* no. *8406.* All collections are deposited in the Long Herbarium.

When the sporocarps are soaked in water for several hours the exoperidium can be easily separated from the endoperidium; the former on drying becomes thin and papery, while the endoperidium after the soaking becomes soft and shows its gelatinous to subfleshy nature.

Araneosa columellata probably occurs throughout the region between Nogales and Tucson, a distance of some 65 miles, as well as, beyond the limits now known, under similar soil and climatic conditions. It is usually associated with *Secotium arizonicum* and externally resembles this plant so closely in size, shape and color that only by examining the gleba can the two be distinguished from each other. *Secotium arizonicum* has been found in Mexico south of Nogales and also near Safford, Arizona, which is about 85 miles northeast of Tucson. It is very probable that *Araneosa columellata* also occurs in these regions since the two plants grow under similar environments.

The present characters of Arachniaceae as now emended indicate that this family probably should be merged with the Lycoperdaceae: the cellular structure of the young stages in the gleba is very similar to that of the immature stages of a *Lycoperdon,* the main difference being the retention at maturity of the cell walls in the gleba in the shape of peridioles while in *Lycoperdon* these walls disappear entirely, leaving the gleba at maturity a mass of spores and capillitia; in certain species of *Arachnion* these cell walls of the peridioles almost disappear, leaving the sporeballs nearly naked as in *A. rufum* and in the Brazilian form of *A. album;* in this case the main distinction between the Arachniaceae and the Lycoperdaceae has practically disappeared.

The writer [2] in 1917 published, as new, *Arachniopsis albicans,* a plant very similar, externally, to *Arachnion,* hence the generic name. He also stated in this article that it differed from *Arachnion* in having a true capillitium, a cartilaginous endoperidium and in not having peridioles. *Arachniopsis albicans* has an apical lacerate mouth (FIG. 7, from type material), is hypogeous when young

[2] Long, W. H. Notes on new or rare species of Gasteromycetes. Mycologia **9**: 271–274. 1917.

becoming partially exposed at maturity, and is without a sterile base. No claim was ever made by the writer that this plant belongs to the Arachniaceae. It apparently should be placed in the Lycoperdaceae, but under what tribe can not be stated since nothing is known of its early stages. It is near the genus, *Lycoperdon,* but its hypogeous habitat, cartilaginous endoperidium and irregular lacerate mouth would exclude it from this genus.

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NOTES ON ENDOCHYTRIUM DU PLESSIS

John S. Karling

In October 1933, Du Plessis described a new species of *Synchytrium, S. Cotulae,* on *Cotula coronopifolia* from South Africa in which the zoösporangia are delimited within the walls of the resting spore while the latter is still embedded in the host tissues. Because of this characteristic, he proposed a new subgenus, *Endochytrium,* to include this fungus. In January of the same year, however, Sparrow used this generic name for a group of operculate chytrids which inhabit filaments of *Cladophora* and other algae. Both authors accordingly proposed *Endochytrium* within the same year, but Sparrow's paper appeared eight months earlier than Du Plessis' contribution. Under present rules of nomenclature, Sparrow's genus has priority, while Du Plessis' subgenus becomes untenable and should be discarded. To avoid possible confusion in the future, I propose another name, **Endosynchytrium**, for Du Plessis' subgenus.

Endochytrium Sparrow includes at present two well-defined operculate species, *E. operculatum* (de Wildeman) Karling (**1937**) and *E. digitatum* Karling (**1938**). *Entophlyctis* sp., Karling (pro parte, **1931**) and *E. maxima* Dangeard (**1932**) are possibly identical to *E. operculatum* also. *Endochytrium oophilum* Sparrow is a doubtful species. Sparrow found a few ovate operculate sporangia in rotifer eggs which he believed related to a species of *Endochytrium.* However, no rhizoids or evidence of a rhizomycelium were observed in connection with the sporangia. It is not improbable that Sparrow's fungus may relate to *E. operculatum,* since the author (Karling **1937**) has often found this species inhibiting animal material such as cysts of *Diplophysalis stagnalis, D. nitellarum, Vampyrella* sp., and liver fluke ova where the rhizoids may frequently be obscured by the dense cell content. *Endochytrium oophilum,* none the less, still stands as a questionable species.

Entophlyctis pseudodistomum, described by Domjan (1935) as a saprophyte in dead filaments of *Zygnema* and *Spirogyra* in Hungary, is obviously a species of *Endochytrium* also. It has the same structure and type of development characteristic of *Endochytrium* species, and its sporangia are operculate, a character which excludes it at once from *Entophlyctis.* Except for the endogenous method of resting spore development, it is very similar to *E. operculatum,* but whether or not the two species are identical is uncertain at present. I am nevertheless transferring Domjan's species to *Endochytrium* and designating it as **E. pseudodistomum** (Domjan) comb. nov.

In this note I am also recording the occurrence of two species, *Olpidium Stigeoclonii* de Wildeman and *Lagenidium pygmaeum* Zopf, which have not been previously reported in America, as far as I am aware. In 1900 de Wildeman reported *O. Stigeoclonii* as a parasite in cells of *Stigeoclonium* sp. in Belgium, and 31 years later he gave a fuller account with illustrations of its development. Unlike other members of *Olpidium,* the protoplast of this species exudes successive droplets or globules of protoplasm from the mouth of a comparatively long exit tube. These globules free themselves very slowly from the mother mass, become amoeboid, and then momentarily develop a posterior flagellum. The flagellum is lost almost at once, and the amoeboid cells then creep away and infect other host cells. Resting spores have not been seen, and besides the early infectious stages and developmental phases of the thallus and sporangium, nothing more is known about *O. Stigeoclonii.* The unusual behavior of the protoplast in sporogenesis, however, leads one to question the validity of this species as a member of *Olpidium.*

I have frequently collected this intracellular parasite in *Stigeoclonium tenue* at Candlewood Lake near New Milford, Connecticut, and have observed many of the stages described by de Wildeman. Lack of time has prevented further study of this fungus and at present I am unable to add anything new on its identity and relationship.

Lagenidium pygmaeum was described by Zopf in 1887 in pollen grains of *Pinus sylvestris, P. austriaca, P. Laricio,* and *P. Pallasiana* in Germany. It was subsequently reported in pollen grains

in Switzerland, Belgium, and Denmark by Maurizio (**1895**), de Wildeman (**1895**), and Petersen (**1909**, **1910**), respectively. Schultz-Danzig (**1923**) later recorded it in *Cosmarium pyramidatum* from Germany. I have collected this species each spring for a number of years in pollen of *P. austriaca* in Van Cortlandt Park, New York City, and succeeded in transferring it to pollen of *P. sylvestris, P. Banksiana, P. densiflora, P. Strobus, P. austriaca* var. *nigra,* and *Abies canadensis.* Numerous attempts have also been made to infect other hosts, such as living and killed cells of *Nitella flexilis, Chara coronata, Cladophora glomerata, Pithophora* sp., *S. crassa, Mougeotia* sp., and *Hydrodictyon reticulatum,* without success. These negative results lead me to question Schultz-Danzig's report on the occurrence of *L. pygmaeum* in *Cosmarium pyramidatum.* He based his claim on the presence of an irregular, lobed, sac-like thallus with an exit tube which is rarely branched and the fact that in the same culture were numerous pollen grains infected with *L. pygmaeum.* It is possible that his fungus may relate to dwarf thalli of *Myzocytium* or another species of *Lagenidium* which parasitize algae.

Zopf's report that the zoöspores of *L. pygmaeum* are 16 to 18 μ long is obviously wrong. I have frequently observed their formation and activity and found them to be approximately $5 \times 8\ \mu$ in size and bean-shaped with a ventral groove. The thallus of this species is strikingly like that of *Olpidium,* and unless zoöspore emergence is observed, it may be easily mistaken for this chytrid. Fischer (**1892**) believed that the intramatrical resting spores of *Rhizophidium pollinis* reported by Cornu (**1872**, p. 121) may possibly relate to *L. pygmaeum* instead of to that rhizidiaceous chytrid.

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NEW SPECIES OF TENNESSEE FUNGI

John Dearness

Ever since the unfortunate fire which destroyed the herbarium of The University of Tennessee in January, 1934, Dr. L. R. Hesler and other members of the botanical staff have been making special efforts to rebuild it. The writer has had the opportunity of examining a number of fine collections of micro-fungi which they have made chiefly in the Great Smoky Mountains National Park. Among them are the following which do not seem to be described in the twenty-five volumes of Saccardo's Sylloge Fungorum or other accessible taxonomies. They are placed in the generic order adopted in Clements and Shear's "Genera of Fungi."

Peronospora Ficariae Tul.

Parasitic on *Trautvetteria carolinensis* (Walt.) Vail. Sevier Co., Great Smoky Mountains National Park; 15 May, 1938. L. R. Hesler, *11400*. A new host-record.

Phyllosticta Iteae sp. nov.

Maculae numerous, scattered, confluence infrequent, pale reddish-brown above, very pale beneath, circular, bounded by a dark, very narrow line, no discoloration beyond the boundary line, 2–4 mm. in diameter. Pycnidia epiphyllous, amphigenous on a few spots, minutely pustulate, darker than the spot, central pore up to 15 μ wide, not numerous, often in a circle, small, 85–125 μ. Conidia hyaline, globose or broadly elliptic, granular, 6–9 $\times$ 4½–6 μ.

On living leaves of *Itea virginica* L.; Rugby, Tenn.; 31 May, 1934. L. R. Hesler, *6201*, (D. *8735*).

Of the six Phyllostictae on related host-genera, this seems nearest *P. Mitellae* Peck.

Phyllosticta Hesleri sp. nov.

Maculae grayish brown arid areas seeming to begin at the tips of the lobes and extending towards the petiole, blighting large

portions, in some cases nearly the whole of the leaf. Pycnidia black, numerous on the upper side, few on the lower side of the leaf, thickly scattered over the whole discolored portion, mostly centrally depressed, 125–270 μ in diameter, stoma a pore or irregular cleft, the floor much thinner than the upper wall. Conidia hyaline, oblong with rounded ends, guttate and granular, continuous, 12–21 $\times$ 3.75–4.8 μ, on short conidiophores 2 μ thick.

Parasitic on living leaves of *Acer saccharum* Marsh; University Campus, Knoxville, Tenn., 19 Aug., 1938; J. O. Andes (L. R. Hesler, *10674*), (D. *8904*).

Now and again among the others a pycnidium may be found with broadly elliptic or subpiriform conidia about 10 $\times$ 7 μ; whether a variant or different species not determined.

Dothiorella Mali Karst. **fructus** var. nov.

Cells 16 to 30 or more in a stroma; conidia 8–12 (15) $\times$ 3. This is near *D. Cydoniae* Oud. which Saccardo says is very near *D. Mali.* (Sacc. Syll. **18**: 289.)

On decaying fruit of apple, at base of Chimneys, Sevier Co., Great Smoky Mountains National Park, altitude 3000 ft., 17 April, 1938. L. R. Hesler and J. P. Porter, *11277,* (D. *8957*).

D. Mali has conidia "6–10 $\times$ 3 μ"; *D. Cydoniae,* "10–12 $\times$ 3.5 μ."

Phlyctaena Tiliae sp. nov.

Maculae scattered, sometimes closely congregated and becoming confluent over considerable area; yellowish drab at first, brown when old, angular when separate, bounded by veinlets, similar on both sides. Pycnidia darker brown than the spots, about equally visible on both sides but stomate on the lower side only, very thin-walled, pale amber-colored, opening widely, 150–245 μ in diameter. Conidia whitish-hyaline in the mass, issuing naturally in conspicuous tongues or thick tendrils, curved, staining renders 1 to 3 septa visible in matured examples, 33–43 $\times$ 1–1.2 μ.

Parasitic on living leaves of *Tilia americana* L.; Cades Cove, Blount Co., Great Smoky Mountains National Park, 2 July, 1934. L. R. Hesler, *7258* and *8193,* (D. *8731*).

Under the hand-lens very similar to *Cylindrosporium irregulare* (Peck) Dearn.

Septoria farfaricola sp. nov.

Maculae very numerous, thickly scattered, circular, a well-marked, small, white central portion, sometimes bordered and surrounded by a larger grayish portion, black rimmed, the rim with a dark purple band about 1 mm. wide; very pale beneath some of which have unbordered white spots. Pycnidia black, numerous in the older spots, one or more nearly always present in the central white portion of the spots, epiphyllous, 50–60 μ in diameter. Conidia hyaline, straight or curved, continuous, eguttulate, 30–42 $\mu \times 1\ \mu$.

On living leaves of *Tussilago Farfara* L., Greenbrier Pinnacle, Sevier Co., Great Smoky Mountains National Park, Tenn.; 7 June, 1934. L. R. Hesler, *7312,* (D. *8762*).

The spots resemble those of *Septoria Farfarae* Passer. but fruitings are different, the conidia being $55 \times 3\ \mu$ and multiseptate.

Septoria Pachysandrae sp. nov.

Maculae scattered, numerous, white, circular, oftener angular, limited by a red line, small, 1–3 mm., similar on both sides.

Pycnidia numerous, mostly epiphyllous but visible below, brown, 60–120 μ, centrally depressed, opening wide. Conidia hyaline, straight or curved, no septa observed, seem to be on short conidiophores, $19–24 \times 0.5–0.7\ \mu$.

Injuriously parasitic on living leaves of *Pachysandra procumbens* Michx.; in Savage's Gardens, Coal Creek, Tenn.; 3 July, 1934. Coll. J. K. Underwood; (Hesler *7342*), (D. *8769*).

The genus- and species-history of this plant leads one to look among its neighbors for parasitic fungi found upon it. *Septoria acerella* Sacc. and *S. Negundinis* Ellis & Dearn. have numerous small white spots but the conidia of the three are different. From some pycnidia of this collection there issues in water a stout thread of very minute spores (microconidia ?) about $2.5–3 \times 0.6\ \mu$.

Leptothyrium parvulum sp. nov.

Maculae none. Pycnidia numerous, very minute, 0.15 mm. evenly scattered over a portion or the whole of the leaf, epiphyllous, very few seen on the lower side, dimidiate, scutate, black, obscurely radiate, margin thin, pale, stoma central, a minute pore. Conidia hyaline, minute, elliptic, about $3 \times 2\ \mu$; conidiophores few, $10–15 \times 1\ \mu$.

On living leaves of *Rhododendron punctatum,* in same collection as *Gloeosporium ferrugineum;* Mt. Pisgah, N. C., 5600 ft.; 16 June, 1935. L. R. Hesler, *8012, 8013,* (D. *8974*).

Leptostromella Bignoniae sp. nov.

Maculae scattered, arid, nearly white, bordered by a distinct, narrow black ridge, surrounded by a dark purple border 1 to 3 mm. wide, the arid portion an irregular circle 1 mm. to 1 cm. in diameter, similar but paler beneath. Pycnidia black, circular, dimidiate, radiate amphigenous, but more numerous above, minute, 48–105 μ in diameter. Conidia hyaline, straight or somewhat curved, 16–28 $\times$ .75–1.1 μ.

Parasitic on living leaves of *Bignonia capreolata* L.; in a garden, Coal Creek, Tenn.; 28 April, 1934. L. R. Hesler, *7259,* (D. *8732*).

Gloeosporium ferrugineum sp. nov.

Spots epiphyllous, ferruginous, circular, 3 to 10 mm. in diameter, dull yellow margin 1–2 mm. wide, scattered, much paler below and lacking the yellow margin. Acervuli epiphyllous only, scattered over the spot, black, on some spots crowded and appearing as a dark irregular streak just inside of the yellow-margin, opening as a small perforation or a slit in the cuticle, the position sometimes marked by a spore-cirrus. Conidia hyaline, if not washed away remaining as a white cone or cirrus over the opening of the acervulus, straight, cylindric, or narrowed towards one end, obtusely pointed at the ends, contents homogeneous, 13–15 (17) $\times$ 2.75–3.1 μ; conidiophores 10–13 $\times$ 2.5 μ.

On living leaves of *Rhododendron punctatum* Andr., Mt. Pisgah, N. C., alt. 5600 ft.; 16 June, 1935. L. R. Hesler, *8012,* (D. *8801*).

In another collection the yellow margin of the spots is very narrow and obscure. In *G. Rhododendri* Briosi & Cavara the spots are irregular and arescent and the conidia 15–20 $\times$ 4–5 μ.

Gloeosporium Ilicis sp. nov.

Typical leaf-spots lacking; distantly scattered, small groups of acervuli, easily seen, resemble spots. Acervuli amphigenous, prominently erumpent, each more or less covered by a colorless, cuticular scale, 3 to 10 in a small, compact group, becoming somewhat confluent, finally forming a dark, circular scab 1 to 2 mm. in diameter and sometimes appearing on the opposite side of the leaf

as a smaller darkened area, 200 to 600 μ. Conidia hyaline, subglobose to elliptic, varying towards quadrate, 4–9 × 4–5 μ; in youngest sections seeming histogenic, in the older sections of the darkened masses there are distinct conidiophores up to 15 × 1.5–2.1 μ.

On living leaves and midribs of *Ilex opaca;* Cade's Cove, Blount Co., Great Smoky Mountains National Park, Tenn., 15 June, 1934. L. R. Hesler, *7359,* (D. *8774*).

Gloeosporium papulatum sp. nov.

Maculae thickly scattered, sometimes incompletely confluent through crowding, circular, mostly 2.5–2.75 mm. in diameter, cinnamon buff, narrow, dark gray border, much paler beneath. Acervuli 1–5 small, whitish blisters or papulae rising 30–100 μ, crowded in the center of the spot, usually on a small, slightly darkened area, mostly epiphyllous, circular becoming irregular, 40–300 μ in diameter or length, at first a mucous granular mass.

Conidia hyaline, subglobose, to broadly elliptic or oval, 3–3.4 μ; no conidiophores observed.

On living leaves of *Rubus canadensis* L.; Mt. LeConte, Sevier Co., Great Smoky Mountains National Park, Tenn.; alt. 2800 ft. L. R. Hesler, *7362,* (D. *8775*).

Coryneum Rhododendri Schw. **fusoideum** var. nov.

Coryneum Rhododendri Schw. and *C. triseptatum* Peck on *Rhododendron* are described in Sacc. Syll. **3**: 781. The form under notice has features common to both. The conidia of the former are said to be oval or piriform on short, thick, septate pedicels. Those of the latter are described as oblong-piriform, 15 to 18 μ long, at first hyaline and biseptate and then 3-septate, the end cells hyaline, the others colored on basidia of equal length, easily deciduous. To the latter Peck adds "the most remarkable feature of the spores is the broad, colored central cell sharply contrasted with the two hyaline cells below it and the single one above it." Having studied Peck's type collection I am able to add that the broad, dark-colored cell is 7–8 μ wide, nearly twice as wide as any of the three nearly hyaline cells and that the conidia are borne on branches of dendriform conidiophores in units 31–42 μ long and about half this width. On one leaf a species of *Monochaetia* is also present.

The conidia of the var. are fusoid to oblong-elliptic, on simple or slightly branched 'phores, of four similar brown cells. The acervuli are in somewhat concentric series on large ashy-gray portions of the leaves.

Apparently parasitic on living leaves of *Rhododendron catawbiense* Michx. Roan Mt., Carter Co., Tenn.; alt. 6300 ft. Coll.: A. J. Sharp, 5 May, 1934. (L. R. Hesler, *7321*), (D. *8764*).

CERCOSPORIDIUM DESMANTHI (Ellis & Kellerm.) Earle.

Cercospora condensata var. *Desmanthi* Ellis & Kellerm.

Parasitic on living leaves of *Desmanthus illinoensis,* 3 Sept. 1934. L. R. Hesler *7352,* (D. *8771*).

Petrak transferred this species to *Camptomeris* which is ranked as a synonym or subgenus of *Cercosporidium* in Clements and Shear's "Genera of Fungi."

Cercospora Halesiae sp. nov.

Spots indefinite, no boundary mark, scattered, mottled brown, more distinct above, 1 mm. to 2 cm., mostly subcircular. Fertile hyphae on shallow, brown tubercles, fascicled, 2–8 on a tubercle, bright brown, seldom quite straight, 30–75 $\times$ 5 μ, 2–5 septate. Conidia obclavate, pale-brown, attenuate apically, (30) 47–104 $\times$ 5, up to 8-septate.

Parasitic on living leaves of *Halesia carolina* L.; Bote Mt., Blount Co., Great Smoky Mountains National Park; 18 Aug., 1937. C. W. Greene (L. R. Hesler *11280*), (D. *8959*).

CLADOSPORIUM EPIPHYLLUM (Pers.) Fries.

Lindau names numerous arboreal hosts of which the fallen or dead leaves are marked by circular spots produced by *Cladosporium epiphyllum* (Rabh. Die Pilze, Abt. 8. I: 804).

This fungus, rather briefly described, may be the cause of circular dark spots on the yellowed and still green leaves of *Robinia pseudo-acacia* collected on Mt. LeConte, Sevier Co., Great Smoky Mountains National Park, Tenn., at alt. 2800 ft.; 5 July, 1934. L. R. Hesler, *7341*.

Briosia Azaleae (Peck) comb. nov.

Syn. *Periconia Azaleae* Peck, Ann. Rep. N. Y. State Mus. **25**: 93. 1873.
Sporocybe Azaleae (Peck) Sacc. Syll. Fung. **4**: 608. 1886.

Synnemata scattered or gregarious, brown throughout, terminating in a capitular subglobose mass of spores, 0.5–2.2 mm. long by 60–100 μ thick. Spores briefly catenulate, progressively maturing, brown, becoming nearly globose, 3–7.5 $\times$ 2.75–4.5 μ.

A Stilbaceous parasite on buds and twig terminals of *Rhododendron* spp.; *Briosia* is *Sporocybe* with catenate sporulation. Alum Cave, Great Smoky Mts. Nat. Park, Nov. 18, 1938, L. R. Hesler and A. J. Sharp, *11883;* common where a mountain stream crosses the road on the way up to Clingman's Dome, August 18, 1939, Dearness *9000*. No. 11883 was compared with Peck's type example. In descriptions the differences are slight between this and *Briosia ampelophaga* Cavara on the wine grape, the type of the genus.

A careful study of this bud-blight of *Azaleae* extending over several seasons was published by W. H. Davis in Phytopathology, June 1938, pp. 517–528, well illustrated.

Respecting Descriptions in Latin.—Space in Mycologia is at a premium. Papers of special interest to readers of this Journal are for lack of space going elsewhere to less interested constituencies. The latinized descriptions might have been offered in this paper but logically a description in Latin should have exactly the same inclusions and exclusions as the copy in a modern language and therefore occupy nearly equal space. Dictionaries of dead languages like Latin do not supply words for concepts non-existent in the ancient days when these languages were spoken. Modern languages grow to meet the needs of modern sciences. I have not yet discovered the address of any user of these pages who cannot read them or have them locally translated to meet his needs. The latinized descriptions may be expected in that great "clearing-house" the Saccardoan SYLLOGE OMNIUM FUNGORUM. I had the authority of the late Dr. Saccardo's successor, before the war-clouds appeared, for making this statement.

LONDON, ONTARIO.

A NEW WESTERN PHOLIOTA

Elizabeth Eaton Morse

(with 7 figures)

A peculiar agaric has been collected infrequently in the Sierra during the last fourteen years. Specimens were submitted to several mycologists for identification, but no generic name was proposed until a specimen was sent to Dr. John Dearness, London, Canada, who pronounced it a *Pholiota.* Following this lead, the writer sent specimens, notes and photos to him for critical study. His description, accompanied by apology for attempting to describe a dried agaric, is copied verbatim.

Pholiota magnivelata sp. nov.

" Cap—whitish to cremeous, nearly plane, usually irregular, margin inrolled, viscid, 7.6 cm. in diameter.

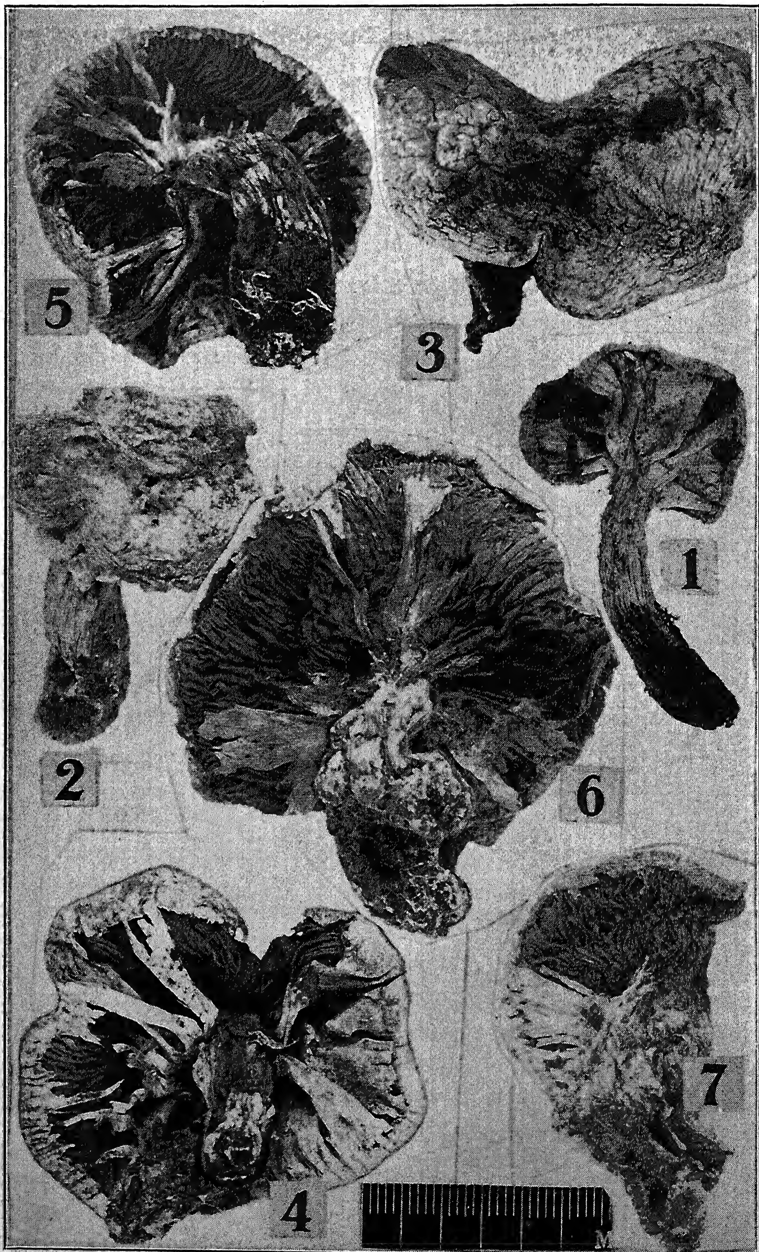
" Flesh—white, rather thin for size of cap, firm, not hard or brittle at first, but becoming hard as it dries.

" Gills—dark rust-color, ventricose, widest near the middle, close, 11 mm. where widest, slightly anastomosed or considerably branched.

" Partial veil—fibrous, a delicate, thin, satiny membrane, fully attached to both margin and stem; at maturity this tissue splits into segments 3–4 cm. long, lower sides partly covered with a white, cottony layer continuous with a similar layer on the stem. *Magnivelata* is a very appropriate term.

" Stem—usually eccentric, concolorous with cap, longitudinally, often deeply ridged, cottony at or near connection with the veil; in cross section a dark brown band one mm. wide under the cuticle, the irregular shrunken tissue inside the band, formerly spongy, shows no evidence of canal or other cavity; sometimes ventricose, sometimes bulbous with base narrowed to quite a sharp point, suggesting growth from decayed buried wood; length 4 cm., longest diameter 1.6 cm., soil-covered on lowest third.

" Spores—the color of the gills, dark-rusty, ocher under microscope, nearly elliptic, some of them flatter on one side, not truncate, some with a short apiculus, smooth under intermediate magnifica-



FIGS. 1–7. *Pholiota magnivelata.*

tion, minutely rough under high power, $7.5\text{–}10 \times 5\text{–}7\ \mu$, average $8.13 \times 5.4\ \mu$, wall of visible thickness.

"Cystidia—none observed.

"Taste and odor—not reported; not distinctive in the dried state."

All the collections inhabited damp soil or humus in open coniferous forest in the Sierra or foothills, at 3500 to 6500 feet elevation, as follows:

General Grant National Park, in bank of dry creek bed in partial shade; July, 1927; E. E. Morse. The type collection in liquid is deposited in the University of California Herbarium, No. *638890*.

Same locality, near Administration building; autumn, 1927; H. Bailey.

Same locality, June 21, 1931; Mrs. H. E. Roberts.

Sequoia National Park, Camp Kaweah; July 7, 1936; Mrs. B. B. Nielsen.

Jonesville, Butte Co., altitude 5500 feet; July 27, 1936; E. B. Copeland. "Dried *in situ*."

Jones Creek, above Jonesville, among dead fir needles under snow during winter; August 7, 1938; H. F. Copeland.

Four miles above Camino, Eldorado Co., "among needles of Pseudotsuga and Taxus, in very shaded forest," May 5, 1940; Frank Taylor, comm. H. F. Copeland.

Collections are deposited in the herbarium of the University of California.

The maximum width of cap was 12 cm. The veil which at first covers the expanded hymenium splits into segments as described and finally disappears entirely.

This article is offered in the hope that other localities may be discovered and that additional information or emendations of the description may be reported. Dr. Dearness writes: "For the third time I have gone over my beliefs about this plant. The veil is certainly remarkable for a *Pholiota*. If this species has ever been published the description has escaped getting into the literature accessible to me." (Letter, August 28, 1940.)

I wish to acknowledge my obligation to Drs. Dearness, Seaver, Bonar, E. B. Copeland, H. F. Copeland and Vera Mentzer Miller, and to each of the collectors.

CALIFORNIA MYCOLOGICAL SOCIETY,
UNIVERSITY OF CALIFORNIA,
BERKELEY, FEBRUARY 1, 1941

EXPLANATION OF FIGURES

FIGS. 1–7. Photographs by W. C. Matthews. *Pholiota magnivelata* Dearness: (1) a young sporophore, cap irregular, not fully developed (met obstruction on one side?), margin inrolled, veil a thin, glabrescent membrane firmly attached to both margin and stipe; stipe fairly equal, deeply longitudinally ridged, showing fragments of woolly adhesions, earth stained in lower half; (2) pileus cremeous to ocher colored, glabrous, margin wavy, stipe fairly equal, patches of soil towards the base; (3) one deep sinus, cuticle much wrinkled, viscid, patches of soil and spores still clinging, stipe eccentric, much narrowed at base; (4) under side of pileus showing tendency to split radially, margin much inrolled, veil broken, some of the segments have disappeared; (5) veil less intact, only shreds left; lamellae very close, show some margins with rounded gaps; stipe gradually enlarged towards a soil-stained and rounded base; "the clean white mycelial fibers suggest wood debris or woody humus rather than soil" (J. D.); (6) the largest sporophore collected, older than 4, 5, or 7, lamellae crowded, additional short lamellae extend in from the margin; stipe much shrunken, ventricose at middle, also showing mycelial fibers at base; (7) one large area of veil intact; both 4 and 7 show areas at bases of stipes which suggest possible attachment to rotting wood.

STAGONOSPORA ARENARIA ON GRASSES[1]

RODERICK SPRAGUE

(WITH 2 FIGURES)

INTRODUCTION

Stagonospora arenaria Sacc. causes a blotch disease of aboveground parts of certain grasses in northern Europe and North America. Since the fungus is little known, the following notes on its taxonomy and distribution are presented. The specimens used in this study are as follows:

On: *Arrhenatherum elatius,* State College, Pa., St. John P. Chilton, Aug. 23, 1938; *A. elatius,* Cheshire, England, J. W. Ellis, Oct. 1914; *Dactylis glomerata,* Wallace Bridge, Oreg., R. Sprague, June 23, 1937 (O.S.C. *742*); *D. glomerata,* Hopkinsville, Warren Co., Ohio, W. B. Cooke (*14,531*) Oct. 20, 1939; *D. glomerata,* Foster, Warren Co., Ohio, W. B. Cooke (*14,501*) Oct. 9, 1939; *Elymus glaucus,* Carson, Wash., R. Sprague, Oct. 23, 1937 (O.S.C. *8453*); *E. glaucus,* Tangent, Oreg., R. Sprague, Oct. 15, 1937 (O.S.C. *8487*); *E. glaucus,* Orleans, Linn Co., Oreg., R. Sprague, May 29, 1936 (O.S.C. *10,746*); *E. mollis,* Seward, Alaska, G. F. Gravatt, Aug. 30, 1934 (In Mycological Collections, Bur. Pl. Ind., U. S. Dept. Agr.); *Phalaris arundinacea,* Devil's Lake, Wis., J. J. Davis, Aug. 5, 1913; and *P. arundinacea,* Ames, Iowa, R. Sprague, Sept. 9, 1940.

SYMPTOMATOLOGY

Most of the hosts show characteristic purple or very dark purple-brown lesions. On *Elymus glaucus* and *E. mollis,* the purple spots have light straw or tawny borders. Later the color

[1] Coöperative investigations between the Divisions of Cereal Crops and Diseases and Forage Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture, and the Oregon Agricultural Experiment Station. Published as Technical Paper No. 358 of the Oregon Agricultural Experiment Station with the approval of the Director. Contribution from the Department of Botany.

fades as the attacked leaves die, until finally the lesions become virtually indistinguishable from the general straw- or buff-colored dead host tissue. On *Dactylis glomerata* the elliptical lesions, which are dark purple at first, later fade to buff in the center, develop a few pycnidia and finally fade to straw color. On *Arrhenatherum elatius,* collected in the grass plots at State College, Pa., by S. J. P. Chilton, the purple elongate to oval spots have yellow to fawn colored borders. Lesions on *Phalaris arundinacea* first formed purple areas, which faded to discolored or stramineous color. Grove (3) claimed that *Stagonospora arenaria* produced no spots on affected hosts. However, he dealt with old material or, as will be pointed out, confused several fungi.

PURE CULTURE STUDIES

An isolation from *Arrhenatherum elatius* made by Chilton developed pale buff mycelia with no yeasty or stromatic tissue present, such as is typical for species of *Septoria* isolated from Gramineae. An isolation from *Elymus glaucus* near Tangent, Oreg., developed buff mycelia virtually identical with that sent by Chilton. Both cultures remained sterile on potato dextrose agar held at 40° F.

No host range studies have as yet been made on this group.

MORPHOLOGY

In the study of the pycnidia and pycnospores, use was made of prepared slides following technique discussed in a recent study on *Septoria* species on Gramineae (8).[2]

Pycnidia.—On *Arrhenatherum elatius,* the globose pycnidia have thin walls which are composed of an outer layer of rectangular cells surrounding two layers of somewhat thin-walled cubical cells producing poorly differentiated, blunt bottle-shaped pycnophores, most of which are confined to the basal hemisphere of the pycnidium (FIG. 1, *B*). When spores are mature, the pycnophores are distinguishable, but when the spores are still attached to the wall, the

[2] The assistance of Mrs. Annie Sampson and of the Works Progress Administration under Project 2485 is gratefully acknowledged. Duplicate slides from part of this study are filed in the Mycological Collections, Bureau of Plant Industry, Washington, D. C. The aid of Dr. A. G. Johnson and colleagues in the preparation of this note is gratefully acknowledged.

pycnophores are often scarcely distinguishable from the inner cells of the pycnidium.

On the *Dactylis glomerata,* material from Oregon, the pycnidia are golden brown, obscure, globose, thin-walled and have ill-developed pycnophores. The pycnidia are sunken in the leaf tissue with scarcely erumpent ostioles. The material collected by Cooke in Warren County, Ohio, has golden brown pycnidia, which are semi-mammiform, 90–125 μ diameter, with a slightly browner ring of cells about the ostiole.

On *Elymus glaucus,* all collections show sub-erumpent, light brown strongly flattened elliptical pycnidia $50–80 \times 70–110\ \mu$. The outer walls consist of one to several layers of rectangular thin-walled cells, 3–4 μ thick. Inside this area is an equally thin layer of hyaline, loosely knit rectangular cells, which give rise to blunt bottle-shaped or short cylindric pycnophores (FIG. 1, *C*). The collection from Tangent, Oreg. (O.S.C. *8487*), had pycnidia with very thin outer walls, 2–2.5 μ thick; consisting of single layers of large rectangular cells. Inside of the outer layer, is a central layer, 1–3 cells thick, made up of smaller oblong hyaline cells averaging 1.3–2 μ, with the pycnophores on its inner surface.

A recent collection on *Phalaris arundinacea* from Ames, Iowa, which is assigned to *Stagonospora arenaria* differs somewhat from the others in having sepia-tinted pycnidia, which are strongly erumpent with a large ostiole. The pycnidia are 85–115 μ in diameter.

Pycnospores.—On *Arrhenatherum elatius* from Pennsylvania the spores are hyaline, cylindrical with blunt ends (FIG. 1, *A*), finally 3-septate. Oil drops adjacent to the cross walls give the spores a pseudo-chlorinous aspect. The spores are $36–44 \times 2.5–4\ \mu$, mean size $40.8 \times 3.4\ \mu$ or about 12 times as long as wide. The original description (7) of *Stagonospora Arrhenatheri* Smith & Ramsb. gave spores $25–35 \times 4\ \mu$. Grove (3) reported that Ellis found spores $40–50 \times 6\ \mu$ with 5–6 septa but examination of this material by the writer disclosed spores $22–35 \times 3–3.8\ \mu$ and 3-septate (FIG. 1, *D*).

On *Dactylis glomerata* from Oregon, the spores are larger, hyaline, cylindrical to subfusiform $33–40 \times 3.8–4.6\ \mu$ without constrictions at the septa (FIG. 1, *E*). The material sent by Cooke

has long-cylindric spores with truncated to rounded bases, 1–3 septate, 29–46 × 3.2–4 μ (FIG. 2, *D*).

The pycnospores from *Elymus glaucus* were also hyaline, cylindrical with blunt bases and obtuse (FIG. 2, *A, B, C*) or pointed (FIG. 2, *A*) apices. The spores are 3-septate, not constricted at the septa, 27–61 × 2.5–4.1 μ. The collection on *Elymus mollis* from Alaska also has cylindrical 3-septate, hyaline spores, 28–50 × 3.5–5.0 μ and differs therefore in having slightly wider spores than the collections on *E. glaucus* from Oregon and Washington.

On *Phalaris arundinacea* the spores are fusiform-cylindric to irregularly cylindric with blunt bases, 30–35 × 3.4–3.9 μ in Davis' Wisconsin material (FIG. 2, *F*). The specimen from Ames, Ia., had cylindrical to subfusiform, hyaline, 3-septate spores with small oil drops. The spores were 27–42 × 2.7–4.1 μ, mean size 35.1 × 3.2 μ or 11 times as long as wide (FIG. 2, *E*). These spores were less typical of the species but are possibly immature.

TAXONOMY

Stagonospora arenaria Sacc. was described from Sweden on *Elymus arenarius* (6, p. 124) with hyaline, 3-septate spores 30–35 × 3.5–4 μ in globose-lenticular pycnidia 200–250 μ in diameter. The North American material is readily referable to this species except that the pycnidia are smaller than the measurements given by Saccardo. The writer prefers to emend the original description sufficiently to include the North American material, which, otherwise, is referable to this species.

Material assigned to *Stagonospora arenaria* by European writers appears to be in some confusion with certain brown spored fungi near *Hendersonia mollis* Grove. For instance, through the courtesy of Sir Arthur Hill and Miss E. M. Wakefield of the Kew Herbarium the collections of W. B. Grove were examined. A specimen called *S. arenaria* on *Aira* from Baxterley Common, England (Oct. 15, 1927), had light brown spores 31–37 × 4–5 μ (FIG. 1, *F*). A collection by Rhodes from the banks of the Usk River at Brecon, England, was also determined by Grove as *S. arenaria*. The slide sent by Miss Wakefield showed large thin-walled pycnidia with small ostioles (10–12 μ) and hyaline, soon yellow-brown narrowly fusiform 6–7 septate spores, 40–50 × 2.5–

4.2 μ. These fungi are nearer *Hendersonia* than *Stagonospora* and have their counterpart in saprophytic fungi collected on a number of grasses in western Oregon.

Another fungus from Denmark on *Elymus arenarius, Septoria Elymi* Rostr. (5) was said to have 3-septate spores 38–40 × 5–6 μ, but later Lind (4) reported some with longer spores, 38–70 × 5–6 μ, 1–3 septate, and illustrated the spores as being narrowly fusiform, 2–3 septate, 58–67 × 2.8–4.8 μ. As illustrated (4), the spores are similar to those of *Stagonospora arenaria* on *Elymus*

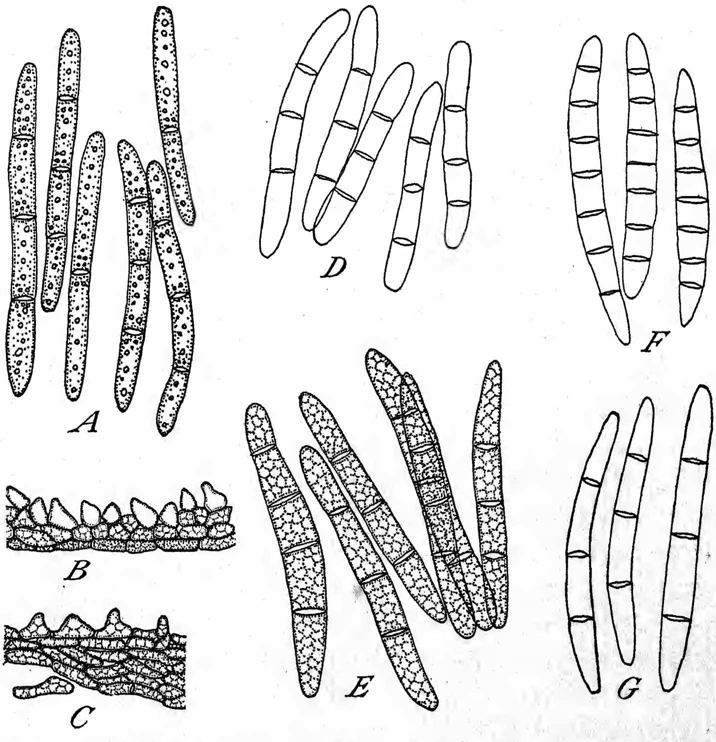


FIG. 1. *A–E, Stagonospora arenaria* Sacc. on various grasses: *A*, pycnospores from *Arrhenatherum elatius*, State College, Pa.; *B*, cross section of pycnidial wall on *Arrhenatherum elatius*, State College, Pa.; *C*, cross section of pycnidial wall on *Elymus glaucus*, Carson, Wash.; *D*, pycnospores from *A. elatius*, Hadlow Rd., Cheshire, England, and *E*, pycnospores from *Dactylis glomerata*, Wallace Bridge, Oreg. (All × 1000). *F*, pycnospores of *Hendersonia* sp. from *Aira caespitosa*, Baxterley Common, England, Oct. 15, 1927; *G*, pycnospores of *Leptosphaeria avenaria* Weber, from *Avena sativa* (Fungi Columb. *4771*). (× 1000.)

glaucus from Linn County, Oreg. (O.S.C. *8,487* and *10,746*), although less so in comparison with the more nearly cylindrical spores of the collection from Carson, Wash.

There are a number of species of *Septoria* on *Elymus* that have been described but none of them are comparable. *Septoria elymicola* Diedicke (**2**) on *Elymus arenarius* has filiform 1-septate spores 40–50 × 1–2 μ and it is near *Septoria Elymi* Ellis & Ev. as noted by Sprague (**8**). *Septoria arenaria* Rostr. on *Ammophila arenaria* has narrow spores, 100× 0.5–1.0 μ (**5**). *Septoria Ammophilae* P. Sydow (**10**) on the same host has non-septate spores 48–60 × 2 μ. While Lind (**4**) unaccountably lists this as a synonym of *Septoria Elymi* Rostr. It is distinct from other species seen. H. Sydow very kindly loaned type material of *Septoria Ammophilae* to the writer who found large, golden, hypophyllous pycnidia with curved or hooked spores.

The North American specimens are referable to the fungus described as *Septoria Elymi* Rostr., which is believed to be the same as Saccardo's ill-described *Stagonospora arenaria*. The group is assigned to *Stagonospora* rather than *Septoria* because the spores are essentially cylindrical or narrowly fusoid, and have average width to length ratios approaching 1 : 10. Also, the pycnidia in most cases are clearly thin-walled, pale brown and thus *Stagonospora*-like. Furthermore, the growth on agar media is cottony, like that of other species of *Stagonospora*, and not mucose like most species of *Septoria* on cereals and grasses. In this connection it is interesting to note that Dr. Davis (**1**, p. 425) assigned a fungus on *Elymus canadensis* from Mellen, Wis., to *Stagonospora arenaria* with the following remarks, "the leaves bear blackish brown spots, but the pycnidia are found also in paler portions of the leaves. The sporules are 20–33 × 3–4 μ, triseptate. Exceptionally 1-, 4-, or 5-septate sporules occur."

The synonomy and emended description of *Stagonospora arenaria* is as follows:

Stagonospora arenaria Sacc. (**6**) (Emended), 1878.
Syn. *Septoria Elymi* Rostr. (**5**) (Non Ellis & Ev.), 1899.
?*Stagonospora Arrhenatheri* Smith & Ramsb. (**7**), 1916.
Stagonospora arenaria var. *minor* Stev. & Trail (**9**), 1886.

Lesions dark purple, purple-black to deep brown, later variously mottled fading to buff or straw; pycnidia scattered not prominent, golden brown to sepia, subglobose, erumpent, ostiolate, thin-walled, 50–160(240) μ diameter; pycnophores short botuliform or sub-cylindric, spores cylindrical or sub-fusiform, bases often blunt tapering to a pointed to blunt apex, hyaline with small chlorine oil drops, 3-(1–4) septate, 26–61 × 2.6–5 μ, often 30–40 × 3.5–4.3 μ, smaller on *Arrhenatherum*.

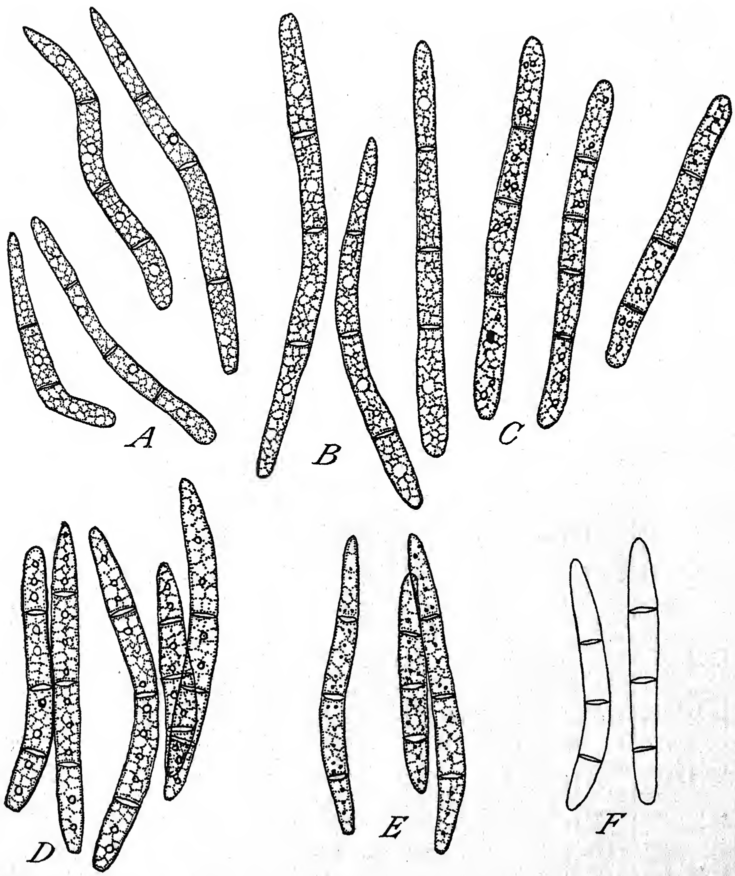


FIG. 2. Pycnospores of *Stagonospora arenaria* from various grasses: *A, Elymus glaucus,* Orleans, Oreg.; *B, E. glaucus,* Tangent, Oreg.; *C, E. glaucus,* Carson, Wash.; *D, Dactylis glomerata,* Hopkinsville, Ohio; *E, Phalaris arundinacea,* Ames, Iowa, Sept. 9, 1940; *F, P. arundinacea,* Devil's Lake, Wis. (All × 1000.)

On leaves, sheaths and culms of living plants of *Elymus arenarius, E. glaucus, E. canadensis, E. mollis, Dactylis glomerata, Arrhenatherum elatius,* and *Phalaris arundinacea* in northern Europe, Alaska, Oregon, Washington, Wisconsin, Ohio and Pennsylvania.

It should be added that *Stagonospora arenaria* is morphologically very similar to the pycnidial stage of *Leptosphaeria avenaria* Weber (*Septoria Avenae* Frank) (**11**), which is *Stagonospora*-like (FIG. 1, *G*). However, the latter fungus does not produce the purple blotching on oats as the former one does on its hosts. Furthermore, *L. avenaria* produces both pycnospores and ascospores in culture, while the writer's cultures of *S. arenaria* thus far have remained sterile. Therefore, for the present, these two fungi are considered distinct. *Stagonospora Arrhenatheri* may prove to belong to *L. avenaria* on further study.

SUMMARY

Stagonospora arenaria Sacc. causes a purple blotch leaf disease of a number of grasses in the north temperate and subarctic regions of the Northern Hemisphere. The emended concept of the species includes a somewhat polymorphic species with triseptate, narrowly cylindrical to subfusiform spores 27–70 × 2.6–5.0 μ.

NORTHERN GREAT PLAINS FIELD STATION,
MANDAN, N. DAK.

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UREDINALES OF NEW GUINEA—IV [1]

George B. Cummins [2]

(with 14 figures)

The 28 species of Uredinales reported in this paper were collected by Mrs. Mary Strong Clemens in Morobe District, New Guinea. Of the 28 species three are transferred as new combinations and 13 are described as new species. The type specimens are deposited in the Arthur Herbarium, Purdue University Agricultural Experiment Station.

Pucciniastrum Potentillae Kom.

On *Potentilla* sp., Mt. Sarawaket, April 14, 1939 (*10134*), May 1939 (*s.n.*), June 8, 1939 (*s.n.*).

Phakopsora Elettariae (Racib.) comb. nov. (*Schroeteriaster Elettariae* Racib. Par. Algen. Pilze Java's **2**: 28. 1900; *Klastopsora Elettariae* Höhnel, Zeits. Gärungsphysiologie **1**: 229. 1912.)

On *Amomum* (*Hornstedia*) sp., Kajabit Mission, Aug. 16, 1939 (*10583*), Dec. 8, 1939 (*10861*). On Zingiberaceae (probably *Amomum*), Wareo, Dec. 26, 1935 (*1370*), Jan. 3, 1936 (*1479*), Jan. 10, 1936 (*1609*), Jan. 12, 1936 (*1662*).

In 1934 Mains (Ann. Myc. **32**: 256–258) concluded that the genus *Schroeteriaster* was closely related to *Uromyces*. Descriptions of the telia of *S. Elettariae* indicate that the species is a *Phakopsora*.

Phakopsora formosana Sydow.

On *Glochidion* sp., Boana, May 23, 1940 (*s.n.*), July 2, 1940 (*s.n.*).

[1] Contribution from the Department of Botany, Purdue University Agricultural Experiment Station, Lafayette, Indiana.

The third article of this series was published in Mycologia **33**: 143–154. 1941.

[2] I am indebted to Drs. E. D. Merrill and S. F. Blake for giving opinions concerning the identity of some of the hosts.

I have not found an adequate description of the uredia but Hiratsuka (Bot. Mag. Tokyo **49**: 785. 1935) includes the species under section *Physopella,* which is correct for the Clemens' specimens. Telia are not present.

RAVENELIA CLEMENSIAE Sydow.

On *Albizzia procera* (Roxb.) Benth., Finschhafen, Sept. 3, 1935 (*53*); Heldsbach, Sept. 9, 1935 (*s.n.*); Kajabit Mission, Sept. 18, 1939 (*s.n.*); Dec. 19, 1939 (*s.n.*); Boana, May 18, 1940 (*s.n.*).

Uromyces Cyanotidis sp. nov. (FIG. 1)

Uredia amphigena, subepidermalia, 0.2–0.5 mm. diam., sparsa vel in maculis lenissime inflatis 1–5 mm. diam. laxe aggregata, pulverulenta, cinnamomea, epidermide rupta conspicue; urediosporae ellipsoideae vel obovoideae, 21–26 × 27–38 μ; membrana 2.5–3 μ cr., obscure cinnamomea, laxiuscule sed valide echinulata; poris germ. 2, aequatorialibus, papilla hyalina obvallatis praeditis. Telia hypophylla, cinnamomea, pulvinata, 0.1–0.3 mm. diam., in greges 1–2 mm. diam.; teliosporae clavatae, ellipsoideae vel globoideae, 15–23 × 23–32 μ; membrana 1–1.5 μ cr. ad apicem 8–18 μ; aureo-brunnea, flavidula vel fere hyalina, levi; pedicello hyalino, brevi.

On *Cyanotis capitata* (Bl.) C. B. Clarke, Sattelberg, Mar. 9, 1936 (*2018,* type); Boana, May 18, 1940 (*s.n.*), June 7, 1940 (*s.n.*).

This rust was first recorded from the Philippine Islands by Cummins (Ann. Myc. **35**: 105. 1937) but was not named.

UROMYCES PHASEOLI (Pers.) Winter.

On *Phaseolus vulgaris* L., Matap station, Mar. 7, 1940 (*11253*).

PUCCINIA VERSICOLOR Dietel & Holw.

On *Andropogon contortus* L., Kajabit Mission, Oct. 1, 1939 (*10713E*).

Puccinia costina (Sydow) comb. nov. (*Uredo costina* Sydow, Ann. Myc. **14**: 355. 1916) (FIG. 2).

Telia minute, 50–80 μ diam., in groups on slightly discolored spots, subepidermal, located beneath stomata but becoming somewhat erumpent, greyish due to germination; teliospores ellipsoid or oblong, rounded at both ends or narrowed below, not or only slightly constricted at the septum, 9–14 (–16) × 23–30 μ; wall hyaline, uniformly 0.5 μ thick, smooth; pedicel short, hyaline and

fragile. The teliospores germinate immediately and apparently lack differentiated germ pores.

On *Costus* sp., Mosum to Lae, July 7, 1939 (*s.n.*); Boana, May 10, 1940 (*11368*), June 12, 1940 (*s.n.*).

The teliospores of this species are the most delicate of any known to me and can easily be overlooked unless numerous.

PUCCINIA FERRUGINEA Lév.

On *Smilax* sp., Galumbu-Finangan, Apr. 25, 1940 (*s.n.*)

Puccinia heroica sp. nov. (FIG. 10, 11)

Pycnia epiphylla, profunde immersa, 125–175 × 325–500 µ. Aecia amphigena in maculis leniter incrassatulis usque ad 1 cm. diam. profunde im-

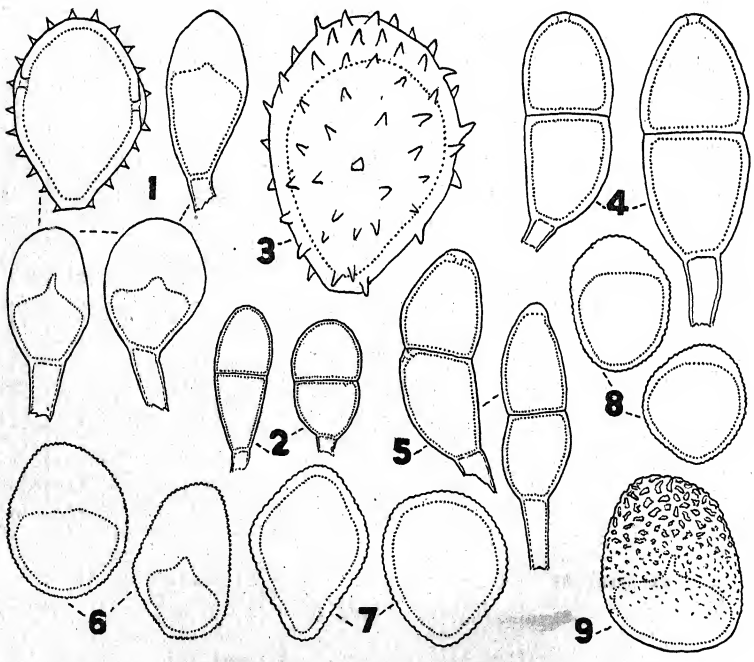

FIG. 1, teliospores and one urediospore of *Uromyces Cyanotidis;* 2, teliospores of *Puccinia costina;* 3, urediospore of *Puccinia largifica;* 4, teliospores of *Puccinia Evodiae;* 5, teliospores of *Puccinia Buchnerae;* 6, aeciospores of *Aecidium wareoense;* 7, aeciospores of *Aecidium elaeocarpicola;* 8, aeciospores of *Aecidium albiceratum;* 9, aeciospore of *Aecidium pachycarpum* (× 650).

mersa, breviter cylindracea, 350–450 μ, diam.; cellulis peridii oblongo-ellipsoidei, 35–45 × 50–75 μ, pariete interiore grosse verrucoso 4–7 μ cr., exteriore levi 5–10 μ cr.; aeciosporae globoideae vel oblongo-ellipsoideae, 35–48 × 45–65 μ; membrana pallide flavida, 2.5–4 μ cr., ad apicem 9–16 μ, grossiuscule verrucosa. Telia hypophylla, subepidermalia, 0.5–2.0 mm. diam., flavida, maculis flavidis 2–4 mm. diam. occupantibus, epidermide rupta elevata; teliosporae cylindraceae, non vel vix constrictae, 18–23 × 69–96 μ; membrana ubique 1.5 μ cr., flavidula, levi; pedicellis concoloris, 12–25 × 100–175 μ, deorsum plus minusve attenuatis. Statim germ.

On *Loranthus* sp., Matap station, Mar. 6, 1940 (*11245*).

The telia of this species occupy the center of yellowish spots which have a somewhat corky appearance. They lack the usual appearance of telia and apparently this is also true of fresh material, since Mrs. Clemens failed to observe them and only accidentally gathered them with the host material. *P. heroica* is generally similar to *P. macrocarya* Racib., as regards teliospores, but the aeciospores are larger, more coarsely marked and have a pronounced apical thickening.

PUCCINIA MACROCARYA Racib. (FIG. 12, 13)

Pycnia epiphyllous, subepidermal, deep-seated, globoid or flask-shaped, paraphysate, 150–250 μ diam. Aecia hypophyllous or becoming amphigenous, subepidermal, deep-seated, 0.3–0.5 × 0.5–1 mm., short-cylindric but the peridium usually broken off, grouped on pulvinate galls 2–8 mm. diam.; peridial cells rhomboidal, 30–45 × 50–75 μ, inner wall coarsely rugose, 5–6 μ thick, outer wall nearly smooth, 8–10 μ thick; aeciospores angularly globoid or broadly oblong, 33–39 × 39–46 μ; wall hyaline, 3–4 μ thick, closely and rather coarsely verrucose. Uredia unknown and probably not formed. Telia amphigenous, occurring singly, pulvinate, 0.4–1.0 mm. diam.; teliospores cylindric or oblong-cylindric, rounded at both ends or somewhat narrowed below, not or very slightly constricted at the septum, 23–30 × 72–89 μ; wall yellowish or nearly hyaline, uniformly 2–3 μ thick, smooth; pedicel concolorous, 13–23 μ wide and up to 170 μ long, thick walled, 3–6 μ. The spores germinate at once.

On *Loranthus* sp., Yoangen, June 18, 1936 (*3381b*); Sugu-Gaeng, Apr. 29, 1940 (*s.n.*).

Although Raciborski's description (Par. Algen Pilze Java's **3**: 11. 1900) is brief I feel confident that this New Guinea rust is *P. macrocarya*. He gives the aeciospores as 38 × 44 μ, the telio-

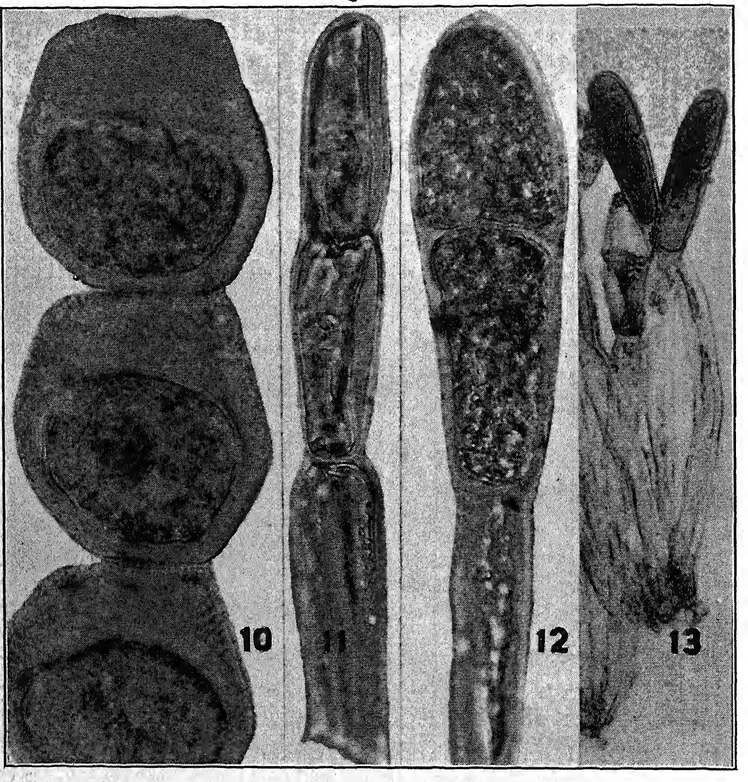

FIG. 10, aeciospores of *Puccinia heroica;* 11, teliospore of *Puccinia heroica;* 12, teliospore of *Puccinia macrocarya* (× 800); 13, teliospores of *Puccinia macrocarya* (× 250).

spores as 20–24 × 70–90 μ and the pedicel as 24 μ wide and up to 180 μ long. The Sydows (Monog. Ured. 1: 589. 1903) state that they did not see the specimen and I find no record of its subsequent collection. For these reasons the above description is provided.

Puccinia Evodiae sp. nov. (FIG. 4)

Pycnia, aecia et uredia nulla vel adhuc ignota. Telia hypophylla, subepidermalia, 125–200 μ diam., castaneo-brunnea, tumores 1–2 mm. diam. occupantibus; teliosporae ellipsoideae vel oblongo-ellipsoideae, utrinque rotundatae vel deorsum attenuatae, medio leniter constrictae, 17–23 × 35–45 μ; membrana ubique 1.5–2 μ cr., castaneo-brunnea, levi; pedicello pallide brunneolo, sporam aequante vel breviore.

On *Evodia* sp., Yunzaing, Aug. 17, 1936 (*3898*).

The characteristic feature of *P. Evodiae* is the small corky gall in which the telia develop. Judging from the description *P. kentaniensis* Pole Evans is similar to this species but has smaller spores. Doidge (Bothalia **2**: 95. 1926) notes that "the corky excrescences in which the teleuto-sori are embedded very much resemble insect galls, and might be passed over as such by the mycologist." This statement applies equally well to *P. Evodiae*.

Puccinia Buchnerae nom. nov. (*Uredo cumula* Arth., Bull. Torrey Club **49**: 195. 1922. Not *Puccinia cumula* Arth. & Cumm. 1933). (FIG. 5).

Telia non visa; teliosporae in uredia ellipsoideae, utrinque plus minusve rotundatae, medio constrictae, 10–13 × 28–38 μ; membrana pallide cinnamomea, 0.5 μ cr., ad apicem 2–2.5 μ cr., levi; pedicello hyalino, sporam breviore, fragili.

On *Buchnera* cf. *urticifolia* R. Br., Boana, May 15, 1940.

This species was previously reported (Mycologia **32**: 373. 1940) under the name *Uredo cumula* Arth.

Puccinia largifica sp. nov. (FIG. 3, 14)

Uredia hypophylla, sparsa, subepidermalia, flavida, 0.1–0.2 mm. diam.; urediosporae obovoideae 25–38 × 38–48 (–56) μ; membrana pallide flavida vel hyalina, 2.5–3 μ cr., ad apicem 8–14 μ, valde aculeata; poris germ. obscuris. Telia hypophylla, subepidermalia, pulvinata, rotundata, 0.1–0.2 mm. diam., castaneo-brunnea; teliosporae oblongo-ellipsoideae, utrinque plus minusve rotundatae, medio constrictae, 27–32 × 65–97 μ; membrana 1.5 μ cr., ad apicem 3–6 μ cr., castaneo-brunnea, levi; poro superiore apicali, inferiore juxta septum sito; pedicello hyalino sporam aequante sed fragili.

On *Senecio glossophyllus* Mattf., Mt. Sarawaket, Mar. 14, 1939 (*10030*), Apr. 13, 1939 (*10137B*), May 1939 (*10293D* type), June 3, 1939 (*s.n.*).

I have only relatively meager specimens of this distinctive rust but Mrs. Clemens has indicated on one of the packets that it is common in her 1937 collection. This material is presumably in the Berlin Museum and will ultimately become available.

UREDO OPERTA Sydow & Butler.

On *Coix lachryma-jobi* L., Wantoat, Jan. 18, 1940 (*11015*).

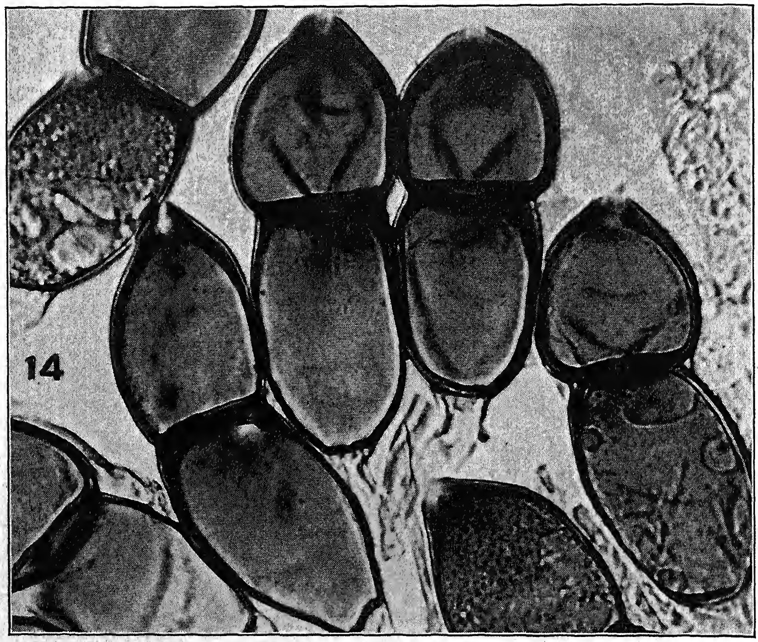

FIG. 14. Teliospores of *Puccinia largifica* (× 800).

Uredo Polliae sp. nov.

Uredia hypophylla, subepidermalia, flavo-brunnea, 0.13–0.3 mm. diam., sparsa vel laxe aggregata in maculis brunneis; urediosporae ellipsoideae vel late ellipsoideae, 23–25 × 26–29 (–32) μ; membrana flavida, 1.5 μ cr. moderate echinulata; poris germ. 2, aequatorialibus.

On *Pollia* near *sorsogonensis* (E. Mey.) Steud., Kajabit Mission, Oct. 3, 1939 (*10714*).

Uredo pseudocannae sp. nov.

Uredia hypophylla, subepidermalia, peridio flavidulo cincta, poro aperta, 80–120 μ diam., in maculis pallide brunneis 2–10 mm. longis laxe aggregata; urediosporae ellipsoideae, obovoideae vel late ellipsoideae, 18–21 × 23–29 μ; membrana pallide flavida vel hyalina 1.5 μ cr., moderate echinulata; poris germ. obscuris.

On *Canna indica* L., Sattelberg, Feb. 28, 1936 (*1908*).

The urediospores have a general resemblance to those of *Puccinia Cannae* (Wint.) P. Henn. but the sori are much smaller and provided with a cellular peridium. Discovery of telia may prove

the species to be similar to or perhaps synonymous with *Phakopsora Elettariae*.

Uredo Passiflorae sp. nov.

Uredia hyophylla, subepidermalia, rotundata, 0.125–2.0 mm. diam., flavida, epidermide primo tecta, in maculis pallidis laxe aggregata vel sparsa; urediosporae ellipsoideae vel obovoideae fere sessiles, 16–23 × 23–28(–33) μ; membrana pallide flavida vel fere hyalina 1–1.5 μ cr., moderate echinulata; poris germ. obscuris.

On *Passiflora* sp., Malalo Mission, Salamaua, May 27, 1936 (*3186*).

UREDO ERIGERONTIS Arth. & Cumm.

On *Erigeron sumatrensis* Retz., Boana, Aug. 21, 1938 (*8721A*); Ogao, June 20, 1939 (*10360*); Samanzing, July 5, 1939 (*10432*).

Short, brownish, peripheral, knob-like paraphyses united below to form a cellular peridium are present in this species, although not mentioned in the original description (Phil. Jour. Sci. **61**: 484. 1936). Future collections should be examined for phakopsoroid telia.

Aecidium innuptum sp. nov.

Pycnia nulla. Aecia hypophylla, subepidermalia, cupulata, pallide flavida, 150–225 μ diam., in maculis pallidis 3–7 mm. diam. aggregata; cellulis peridii late ellipsoideis vel oblongo-ellipsoideis, 14–18 × 19–26 μ, pariete interiore moderate verrucoso 1.5–2 μ cr., exteriore striato 3 μ cr.; aeciosporae globoideae vel ellipsoideae, 11–15 × 14–19 μ; membrana 0.5–1 μ cr. hyalina, minuteque verruculosa.

On *Aristolochia* sp., Matap station, Feb. 6, 1940 (*11107*).

Aecidium elaeocarpicola sp. nov. (FIG. 7)

Pycnia amphigena, subepidermalia, 100–150 μ diam., paraphysata. Aecia hypophylla, profunde immersa, non exserta, 0.2–0.3 mm. diam., in maculis leniter incrassatulis 2–8 mm. diam. aggregata; cellulis peridii haud bene evoluti laxe conjunctis in sporas transeuntibus; aeciosporae variabiles, late ellipsoideae, ellipsoideae vel oblongae, ad apicem et basim frequenter attenuatae, 18–26 × 30–45 μ; membrana pallide brunnea 2 μ cr., moderate verrucosa.

On *Elaeocarpus* sp., Sattelberg, May 1936 (*3024*).

A. elaeocarpicola causes less marked hypertrophy than *A. Puspa* Racib. or *A. Elaeocarpi* Racib., has shorter aeciospores with no apical thickening and has a poorly formed peridium.

AECIDIUM ELAEOCARPI Racib.

On *Elaeocarpus* sp., Sattelberg, Apr. 9, 1936 (*2277*).

The aeciospores of this species are united laterally in uniform horizontal series as well as in vertical chains and tend to separate readily into horizontal strata, somewhat as the teliospores in the microcyclic *Alveolaria*.

Aecidium wareoense sp. nov. (FIG. 6)

Pycnia epiphylla, subcuticularia, 125–200 μ lata, 50–75 μ alta, paraphysata. Aecia hypophylla, cupulata vel breviter cylindracea, 0.2–0.3 mm. diam., albida, in maculis brunneis 3–12 mm. diam. aggregata; cellulis peridii rhomboideis, 20–30 × 30–40 μ pariete interiore verrucoso 4–7 μ cr., exteriore striato 2.5–4 μ cr.; aeciosporae globoideae, plus minusve cuboideae vel oblongae 16–23 × 19–29 μ; membrana hyalina 2 μ cr., ad apicem 7–14 μ, verrucoso.

On *Meliosma ferruginea* Blume, Wareo, Jan. 7, 1936 (*1554*, type); Sattelberg, Mar. 26, 1936 (*2168a*); Yunzaing, June 29, 1936 (*3457*).

While the aecia of *A. wareoense* have the gross appearance of those of *A. Meliosmae-myrianthae* P. Henn. & Shirai the apically thickened spores are entirely different. The fragile peridium of *A. Meliosmae-pungentis* P. Henn. & Shirai and of *A. hornotinum* Cumm. will prevent confusion with *A. wareoense*.

Aecidium Toxocarpi sp. nov.

Pycnia epiphylla, subepidermalia, 150–200 μ lata, 200–300 μ alta. Aecia hypophylla, in maculis pallidis 2–10 mm. diam. laxe aggregata, cupulata; cellulis peridii oblongis vel oblongo-ellipsoideis, 12–18 × 20–30 μ, pariete interiore rugoso 3–3.5 μ cr., exteriore levi 2 μ cr.; aeciosporae late ellipsoideae, ellipsoideae vel oblongae, 15–22 × 22–27 μ; membrana 1–1.5 μ cr., ad apicem usque ad 8 μ cr., pallide flavida vel fere hyalina, minuteque verrucosa.

On *Toxocarpus* sp., Kajabit Mission, Dec. 15, 1939 (*10882*).

AECIDIUM DICHROCEPHALAE P. Henn.

On *Dichrocephala* sp., Finangan to Lapisap, Apr. 26, 1940 (*s.n.*).

This collection, consisting of only two leaves, was gathered by Mrs. Clemens " for distributional record " but the rust which she had collected elsewhere and considered to be identical is microscopically quite different and is described below.

Aecidium matapense sp. nov.

Pycnia hypophylla, subepidermalia, paraphysata, 90–135 μ diam. Aecia hypophylla, in maculis pallide brunneis 0.3–10 mm. diam. aggregata, flavida, cupulata, 0.15–0.25 mm. diam., margine recurvato; cellulis peridii rhomboideis vel oblongo-ellipsoideis, 18–26 $\times$ 29–37 μ, pariete interiore moderate rugoso-verrucoso 2.5–3 μ cr., exteriore striato 3–4 μ cr.; aeciosporae globoideae vel late ellipsoideae, 16–19 $\times$ 18–24 μ; membrana hyalina vel pallide flavidula, 1 μ cr., ad apicem 2.5–6 μ, moderate verrucosa.

On *Dichrocephala latifolia* DC., Matap station, Mar. 6, 1940 (*11246*).

Aecidium albiceratum sp. nov. (FIG. 8)

Pycnia non visa. Aecia hypophylla, in maculis flavidis vel brunneis 2–4 mm. diam. denseque aggregata, cupulata 0.25–0.35 mm. diam.; cellulis peridii rhomboideis vel ellipsoideis, 16–25 $\times$ 26–38 μ, pariete interiore 2.5–3.5 μ cr. rugoso, exteriore 3–5 μ cr. striato; aeciosporae globoideae, ellipsoideae vel oblongo-ellipsoideae, 16–20 $\times$ 20–29 μ; membrana 1.5–2 μ cr., ad apicem 3–8 μ cr., hyalina, moderate verrucosa.

On *Senecio* sp., vicinity of Samanzing, Dec. 10–20, 1938 (*10342W*).

AECIDIUM ? PACHYCARPUM Sydow. (FIG. 9).

On *Senecio* sp., vicinity of Ogao, June 1, 1939 (*10371*).

This specimen differs from *A. pachycarpum* in lacking pycnia and in having peridial cells with thinner walls. The aeciospores are 20–26(–29) $\times$ 26–33(–36) μ with the wall 1.5–2 μ at the base but greatly thickened apically to as much as 23 μ. The collection contains but a single infected leaf but Mrs. Clemens notes indicate various collections in 1937, the specimens presumably at the Berlin Museum.

THE ARTHUR HERBARIUM,
PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION

NEW OR LITTLE KNOWN ASCOMYCETES COLLECTED IN SÃO PAULO IN 1936

Anna E. Jenkins, Helmut P. Krug, and Edith K. Cash

(with 3 figures)

On January 12, 1936, the first two writers of this paper made an excursion to the Biological Station of the State of São Paulo, at Alto da Serra (between São Paulo and Santos), particularly to learn whether *Corynelia brasiliensis* Fitzpatrick was present on *Podocarpus* growing there, and, if so, to gather material of it. This fungus was not found, but two other described fungi were discovered on other plants growing naturally in this moist mountainous area. The following May another mycological excursion was made to Itanhaen (south of Santos).[1] Among the fungi collected in this littoral region of the State of São Paulo were two Discomycetes, one, described, although rarely collected, the other new, and undescribed. These were studied by the third author of this paper.

1. Maireella bertioides (Sacc. & Berl.) Maubl.

The first of the two fungi collected at Alto da Serra attracted attention because of the bright yellow discolorations it produced particularly on the upper surface of leaves of a comparatively small vine. This apparently young plant was not in flower, and, at first, from the infected leaves selected as a mycological specimen, could be identified only as perhaps a Composite.[2] Through the subsequent determination of the fungus, however, it became apparent that the host genus was *Mikania*, and the species, *M. hirsutissima* D.C. This native Brazilian Composite, which is considered to be

[1] During the period that these excursions were made the senior writer was stationed in São Paulo and was working in coöperation with A. A. Bitancourt, Assistant Director, Instituto Biologico de São Paulo.

[2] Identification by E. P. Killip, United States National Herbarium, Washington, D. C.

medicinal (2, 13, p. 265), has the common name of "cipo cabeludo" (hairy vine) (13, p. 265).

Near the centers of the discolored leaf areas, as well as occasionally on the petioles and young stems, were perithecia, often clustered, although sometimes standing apart from the group, or entirely solitary. These perithecia were globose to subglobose, and generally dull black, although occasionally they were glistening (FIG. 1, *A, a* and *b*). In some cases these fruit bodies were collapsed as shown in figure 1, *A, c*. On many of the leaf spots the perithecia had fallen away, and, through the hand lens, dark, circular areas where they had been attached could be seen. As many as twenty points of attachment were counted in the central part of an individual lesion. Although the bases of caespitose perithecia were separate or more or less so, the perithecia themselves were often closely joined together (FIG. 1, *F*). Nearly the entire circumference of the perithecial cavity was lined with numerous asci and filiform paraphyses. The asci were generally clavate and thickened at the apex, with the spore bearing part narrowed abruptly to the short slender stipe (FIG. 1, *D*). In some cases the asci had elongated becoming cylindrical, with walls of even thickness. The spores were here uniseriate, instead of biseriate or inordinate as in the unextended ascus.

The fungus was first traced to *Maireella maculans* Sydow (7, p. 146). This genus and species were established in 1908 to classify an ascomycete also from Alto da Serra, collected by Usteri. The host was reported as of unknown identity, but apparently a Composite. Upon further examination of the literature it was ascertained that during his stay in Rio de Janeiro, Maublanc (8) had also discovered this same ascomycete on several species of a climbing Composite of the genus *Mikania*, notably *M. hirsutissima*, growing on the slopes of Corcovado Mountain. In connection with Maublanc's identification of this species of *Maireella* he made a careful monographic study of the genus. This was named in Maire's honor by Sydow, who discovered that the name selected by Maire was preoccupied. The original generic description (7, p. 145) reads as follows:

"Peritheciis astomis, superficialibus, ut in Cucurbitaria caespitosis."

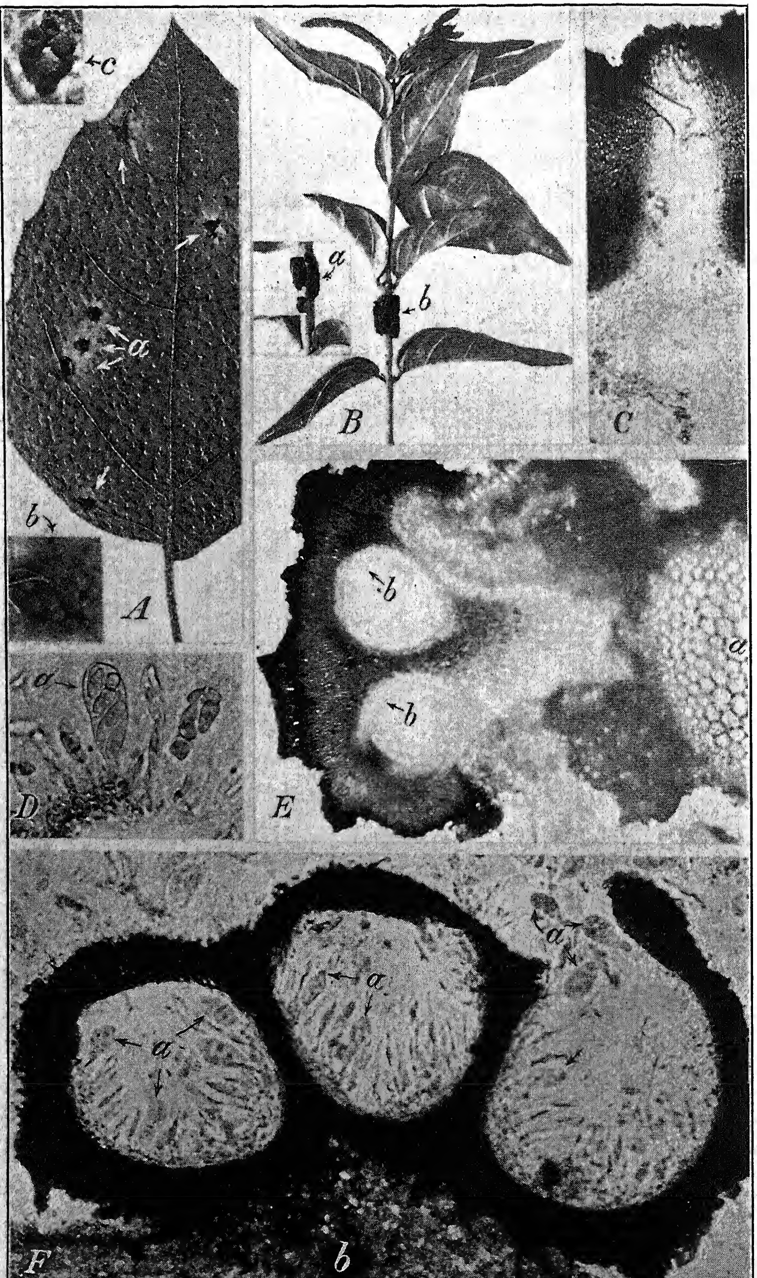

FIG. 1

Maublanc's (8, p. 128) revised description is quoted below:

"Stromata foliicola, erumpentia-superficialia, pulvinata, atra, centro ad folium adfixa, verrucosa-rugulosa, pilis rigidis saepe deciduis ornata; contextu celluloso; mycelio in matricem evoluto, intercellulare, septato-moniliforme. Loculi globosi, plus minusve e stromate erumpentes, ostiolati, tunica a contextu stromatico non distincta. Asci cylindracei vel clavati, 8-sp., paraphysati. Sporidia oblonga, medio 1-septata, hyalina, demum fuscescentia."

The earliest published name for *Maireella maculans* found by Maublanc was that of *Lizonia bertioides* Sacc. & Berl. (16, p. 157), which is based on a specimen collected near Santos by Balansa. Maublanc accordingly made the combination *M. bertioides* (Sacc. & Berl.). Besides the synonyms just named two others reported by Maublanc are *Parodiella caespitosa* Wint.,[3] for which Spegazzini 18, p. 37) erected the new genus *Winteromyces,* and *Lizonia Uleana* Sacc. & Sydow (21, p. 79). Both species were described from specimens collected by Ule in the region of São Francisco, Santa Catharina. This was one of Ule's several places of residence in that state upon his arrival in Brazil from Germany in 1883, and before he went to Rio de Janeiro to live in 1891 (3). The *Parodiella* was originally described on leaves of an undetermined climbing Composite, and *L. Uleana* on leaves of *Mikania* sp.

Judging from the description, which corresponds well with *M. bertioides,* there exists a third binomial representing Ule's collection of this fungus, namely, *Dimerosporium aeruginosum* Wint. (26, p. 87). Winter cited Ule *245,* São Francisco, in his technical description. Ule's collection number *229* is cited for *Lizonia Uleana* by the authors of this species. Apparently at least two other specimens on leaves of *Mikania* collected by Ule were identified as

[3] Rabenhorst-Winter fungi europaei No. 3249 (1885). In Mycological Collections of the Bureau of Plant Industry, Washington, D. C.

FIG. 1. The two fungi from Alto da Serra. *A, D,* and *F, Maireella bertioides* on *Mikania hirsutissima. A.* Black perithecia clustered on yellowed areas on upper leaf surface. *a,* × 1; *b,* × 9; *c,* × 5. *D.* Part of inner layer of perithecium showing asci (g), × 200. Section through fruit body showing three perithecia. *a,* asci, paraphyses shown indistinctly. *F, b,* host tissue, × 125. *B, C, E. Haplosporella Justiciae* on *Justicia* sp. *B, a* and *b,* × 1; *C.* Section through fruit body showing ostioles opening, × 115. *E.* Section showing attachment of fruit body to host tissue (*a*), and two locules with indefinite contents (*b*) as described by Petrak and Sydow for the specimen collected by Ule, × 35. Photographs by M. L. F. Foubert.

D. aeruginosum, for under this name Pazschke (**10**) lists Ule *167,* October 1884, and Rehm (**15**) Ule *167a.* Under the name, *Parodiella dothideoides* Pat., Rehm also lists Ule *47,* collected on leaves of *Mikania.* Pazschke also listed "*Parodiella caespitosa* Wint. Rabh. Fung. Eur. No. *3249.* Ad fol. Compositae Aug. 84. No. *47.*?" It is possible that "Ule No. *47*" in Rehm's list is of the same gathering as the type of *P. caespitosa.* In Theissen's (**22**) treatment of the genus *Dimerosporium, D. aeruginosum* is excluded and referred to *Antennularia.*

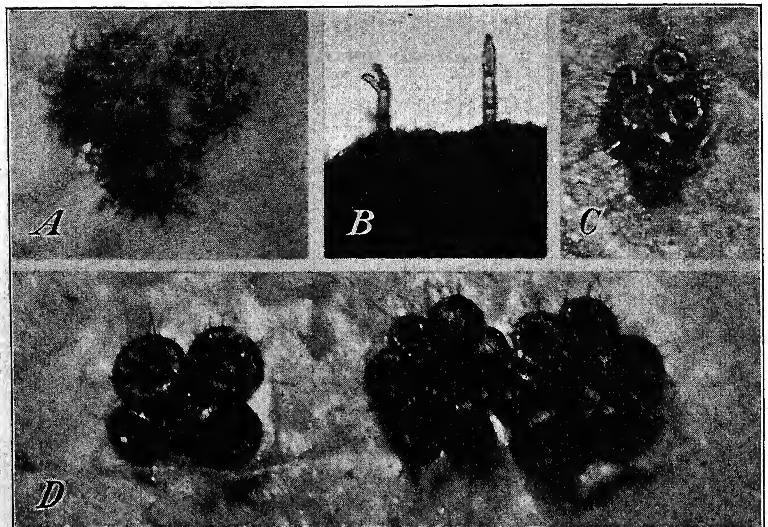

FIG. 2. *A* and *B.* Setae of *Maireella melioloides* on *Mikania* sp. as present on the type specimen of *Dothidella Mikaniae,* São Paulo, May 18, 1901, *A.* Puttemans No. *230.* *A,* × 70; *B,* × 300. *C* and *D.* Setae of *M. bertioides* on *Mikania microlepsis* from Parana, Aug. 14, 1911, P. Dusen. *C,* × 30; *D,* × 60. Photographs by Foubert.

Maublanc recognized a second species of *Maireella.* This was found on leaves of *Mikania* sp. in Rio de Janeiro by Ule, and in the Cantareira Mountains near the city of São Paulo by Puttemans (May 16, 1901, Puttemans *230*). In the latter case the fungus was described by Hennings (4, p. 111) as *Dothidella Mikaniae.* Reviewing the additional taxonomic history of this species, Maublanc made for it the combination of *M. melioloides* (Rehm).

Drawings of both *Maireella melioloides* and *M. bertioides* were published by Maublanc. The setae of *M. melioloides* represented are from the specimen collected by Puttemans mentioned above, and a photograph of the same specimen as represented in the Mycological Collections of the Bureau of Plant Industry is here shown in figure 2, *A* and *B*. This shows the numerous setae on the fruit body including the branched setae, observed by Maublanc. The delicate setae of *M. bertioides* shown in figure 2, *C* and *D*, are present on the specimen from Paraná to be cited presently.

As a result of examining certain phanerogamic specimens of *Mikania* from southern Brazil, filed in the United States National Herbarium, Washington, D. C., several additional records of *Maireella*, apparently *M. bertioides*, have been obtained. These specimens, together with their accession numbers (U. S. Nat. Herb.) are cited below.[4] It will be noted that one specimen is from the state of Parana. Although the date of the specimen from Rio de Janeiro is not given, this is between 1831–38, which is the period during which Miers was in Rio de Janeiro. The *Maireella* in this phanerogamic collection constitutes at once an early record of this fungus and one of the early mycological records for Brazil. The early specimen of José de Campos Novaes, who was referred to by Puttemans (**14**, p. 26), adds Campinas, São Paulo, to the distribution of the fungus, while its occurrence in Campos do Jordão in the same state is shown by the specimen gathered by the North American uredinologist, E. W. D. Holway and his wife, Mrs. Mary W. Holway. Two other comparatively early specimens available from Brazil are from São Leopoldo, in the State of Rio Grande do Sul. The first was collected in 1906 by Theissen (Theissen, Decades fungorum brasiliensium *147*) and the other, cited by Maublanc (**8**, p. 399), by Rick (Rick, Fungi Austro-Americani *323*). Not in all cases on the material exam-

[4] *Mikania argyrei* DC. Rio Cumpriolo, Rio de Janeiro, Federal District, J. Miers 3648. Ex Herb. Miers (U. S. Nat. Herb. 1420920). Campos do Jordão, São Paulo, Apr. 23, 1922, E. W. D. & Mary M. Holway 1089 (U. S. Nat. Herb. 11197261).

Mikania hirsutissima DC. Campinas, São Paulo, Campos Novaes 40 (U. S. Nat. Herb. 389581).

Mikania microlepsis Baker Morretés, Marumby, Parana, Apr. 14, 1911, P. Dusén 12043 (U. S. Nat. Herb. 1281094).

ined were the fructifications of the *Maireella* accompanied by the conspicuous yellow leaf discolorations already mentioned.

A few weeks after making their first gathering of *M. bertioides* at Alto da Serra, Krug and Jenkins returned to select more material for purposes of study, but most of the fruit bodies had fallen and new ones had not developed. During October, 1940, the second author of the paper visited Alto da Serra where he again saw the *Maireella* on *Mikania hirsutissima* at the Biological Station, as well as elsewhere in the forest nearby. At still another place in the vicinity of São Paulo (Parque do Estado) he also collected the fungus on leaves of *M. sericea* Hook. The two collections were compared with the gathering from Alto da Serra of 1936, by Ahmés P. Viégas, who found them to be identical with the specimen collected in 1936.

During the course of the present study it has been discovered that two Ascomycetes discovered and described by F. L. Stevens, viz., *Achorella guianensis* (19, p. 15–16) and *A. costaricensis* (20, p. 30) are actually of the genus *Maireella*. The first species is from British Guiana and the second from Costa Rica. Detailed drawings of the first species accompany its description. The second species also is illustrated, but asci and spores are not shown. Typical material of *A. guianensis* is at hand, and F. L. Stevens' prepared slides of *A. costaricensis* have been lent by Neil E. Stevens of the University of Illinois. However, asci or ascospores have not been found in the sections represented.

Achorella guianensis is clearly a distinct species of *Maireella*. Macroscopically it is of the same general appearance as *M. bertioides*, but the spores are distinct. They are longer and more slender than those of *M. bertioides* and are noticeably pointed at the apices. The measurements given in the original description are 22–29 $\times$ 5–7 μ. For *M. bertioides* Maublanc gave the spore measurements of 18–25 $\times$ 8–11 μ and for the smaller spored and otherwise distinct species *M. melioloides*, those of 14–18 $\times$ 5–6 μ.

Petrak (11, p. 210–211) has recently shown that *Uleodothis andina* Chardon (1, p. 246) is a species of *Maireella*, and that it is distinct from *M. bertioides*. He therefore made the combination *M. andina* (Chardon). This fungus as originally described on leaves of *Mikania ruiziana* Poepp. from Colombia was apparently

immature for the spores are described as hyaline. From Chardon's illustrations and measurements of the spores this Colombian species is similar to **M. guianensis** (Stev.) comb. nov. Jenkins.

Achorella costaricensis was described on *Mikania* sp., collected at Cartago, Costa Rica, in 1923. As a record of *Maireella* this is somewhat earlier than two other specimens available from that country. The phanerogamic specimens concerned are " Plants of Costa Rica Nos. *43463* and *43464*," collected in the vicinity of Santa Maria de Dota, Province de San José, by Paul C. Standley, and Juvenal Valeri, Dec. 26, 1925–Jan. 3, 1926. The first specimen, *Mikania* sp., was examined as filed in the U. S. National Herbarium. The fungus on the leaves is here immature and conidial locules containing minute conidia as described for *A. costaricensis* are present. Several leaves representing the second specimen, *Mikania Skutchii* Blake, were found in the Mycological Collections of the Bureau of Plant Industry, where the mature ascomycete thereon had been identified as *Dimerosporium aeruginosum* by R. W. Davidson. This specimen is in agreement with *M. bertioides* and it is here so identified. *A. costaricensis,* with ascospores described as 21–25 $\times$ 10 μ, and " Plants of Costa Rica " No. *43463–4* are probably also *M. bertioides*.

Maire stated that *Maireella maculans* was a composite *Parodiella* and that it corresponded in the Perisporiales to *Otthia* of the Sphaeriales. Maublanc (8) reviewing the systematic position of the fungus under its different designations gave as his opinion that its affinities were with Dothideales, where it had been classified by Theissen (23), and Theissen and Sydow (24, p. 466). Essentially the same opinion as to *Achorella guianensis* was expressed by F. L. Stevens in connection with his description of this fungus. He commented as follows:

" The general characters of this fungus are Dothideaceous. . . . The hypostroma is Dothideaceous in character and often the stroma is so, too, the perithecia touching each other and fusing (fig. 24), thus the locules with undifferentiated walls appear in a stroma. In other instances spherical perithecia develop upon the stroma, only partially or not at all attached to their neighbors. In such cases the fungus appears Sphaeriaceous rather than Dothideaceous and it clearly represents a border-line form between the two groups."

Petrak (11) also believes that the fungus is dothideaceous but he is of opinion that further research bearing on the systematic position of the genus *Mairella* should be made.

2. HAPLOSPORELLA JUSTICIAE P. Henn.

The second fungus gathered at Alto da Serra occurred as black protrusions (FIG. 1, *B*) on green stems of a low growing plant in bloom, which was later identified as *Justicia* sp. by E. C. Leonard of the U. S. National Herbarium. Sections revealed that the deep-seated protrusions, reaching to the pith of the host plant (FIG. 1, *E, a*), contained locules opening to the surface by a long neck (FIG. 1, *C* and *E*). The locules which it seemed should contain asci, were unfortunately empty, except for indefinite light colored masses lining these cavities (FIG. 1, *E, b*). In this condition the fungus was recognized as an imperfect, described by Hennings (5, p. 385) on the basis of Ule's collection of it in the Amazon region. The name of the fungus and the diagnosis are quoted as follows:

"Haplosporella Justiciae P. Henn. n. sp.; stromatibus carbonaceis, epidermide caulis subhemisphaerico-pulvinatis serie erumpentibus, atris, tuberculato-rugulosis, rimosis, 1½–2½ mm. diam.; peritheciis immersis, globulosis; conidiis cylindraceis, curvulis, obtusis, eguttulatis, hyalino-fuscidulis, 4–5 × 1 μ, conidiophoris hyalinis, brevibus.

"Rio Madeira, St. Maria: An Stengeln von Justicia cynantha Lind. März 1902, No. 3064.

"Das Conidienstadium gehört zweifellos zu einer Dothideaceae, die Stromata brechen reihenweise aus der Rinde der lebenden Stengel in schwarzen Polstern hervor. Die Conidien sind durch Form und Grösse sehr abweichend; doch vermag ich die Art vorläufig nur hierher zu stellen."

Petrak and Sydow (12, p. 343–344), studying the type specimen of *Haplosporella Justiciae,* failed to find conidia. Their description of the fungus is practically in agreement with the illustrations of it here shown. Relative to the fruit layer they state that this is young, and composed of a hyaline filamentous mass. They noted that Hennings first described this fungus "in sched." as an unripe *Dothidea,* then as *Dothiorella Justiciae* P. Henn. before describing it as *Haplosporella.* They state further that in the structure of the stroma and perithecia the fungus greatly resembles *Apioporthe virgultorum* (Fries) Hoehnel, and also that it appears to have a *Diaporthe*-nucleus and may belong to this or a related genus.

Under the circumstances Petrak and Sydow stated that *Haplosporella Justiciae* P. Henn. should be dropped from the literature. It is unfortunate that the specimen from Alto da Serra is in no better condition that Ule's original gathering in the Amazon region.

3. DERMATEA PARASITICA (Wint.) Hoehnel (FIG. 3, *A–B*)

A fungus collected on leaves of Melastomataceae [5] from Itanhaen agrees in every detail with the fungus described by Winter (**25**, p. 173) as *Niptera parasitica* and later referred by Hoehnel (**6**, p. 1524) to *Dermatea*. Comparison with the type specimen, collected by E. Ule in 1883 on leaves of Melastomataceae near São Francisco, Santa Catharina, Brazil, and issued as Rabenhorst Fungi europaei et extraeuropaei *3167*, confirmed this identification. As noted by Hoehnel (l.c.), Spegazzini also studied the same fungus from collections made by Puiggari in Apiahy 1882–1888 (nos. *2757–2931*) and described it under the name *Fabraea? Melastomacearum* (**17**, p. 590).

Whether the various foliicolous discomycetes referred to *Dermatea* should be retained in this genus is doubtful, but pending a critical revision of such species, this record of the 1936 collection is made under Hoehnel's name.

4. **Laetinaevia Blechni** sp. nov. (FIG. 3, *C*)

Apothecia hypophyllous, subepidermal, elliptic to oblong in outline, 0.5–1 × 0.5 mm., or confluent and reaching 2–3 mm. in length, arranged in closely parallel rows at the margin of the pinna or extending from the midrib to the margin and forming blackened spots 3–5 × 1–3 mm.; hymenium buff citrine, drying bone brown or fuscous to black (Ridgway), opening by a longitudinal slit, remaining sunken and surrounded by the torn discolored epidermis of the host which makes an undulating, whitish border; asci cylindrical, gradually narrowed toward the base and apex, 75–90 × 10–13 μ; spores irregularly biseriate, hyaline, 2-celled, with one small guttule in each cell, not constricted, broadly fusoid or biconic, sometimes unsymmetrical and irregular from crowding in the ascus, 15–18 × 7–9 μ; paraphyses hyaline, septate, filiform, 2 μ in diam., thickened and yellow at the tips and coalescing to form a dense yel-

[5] Identification by S. F. Blake, U. S. Department of Agriculture, Washington, D. C.

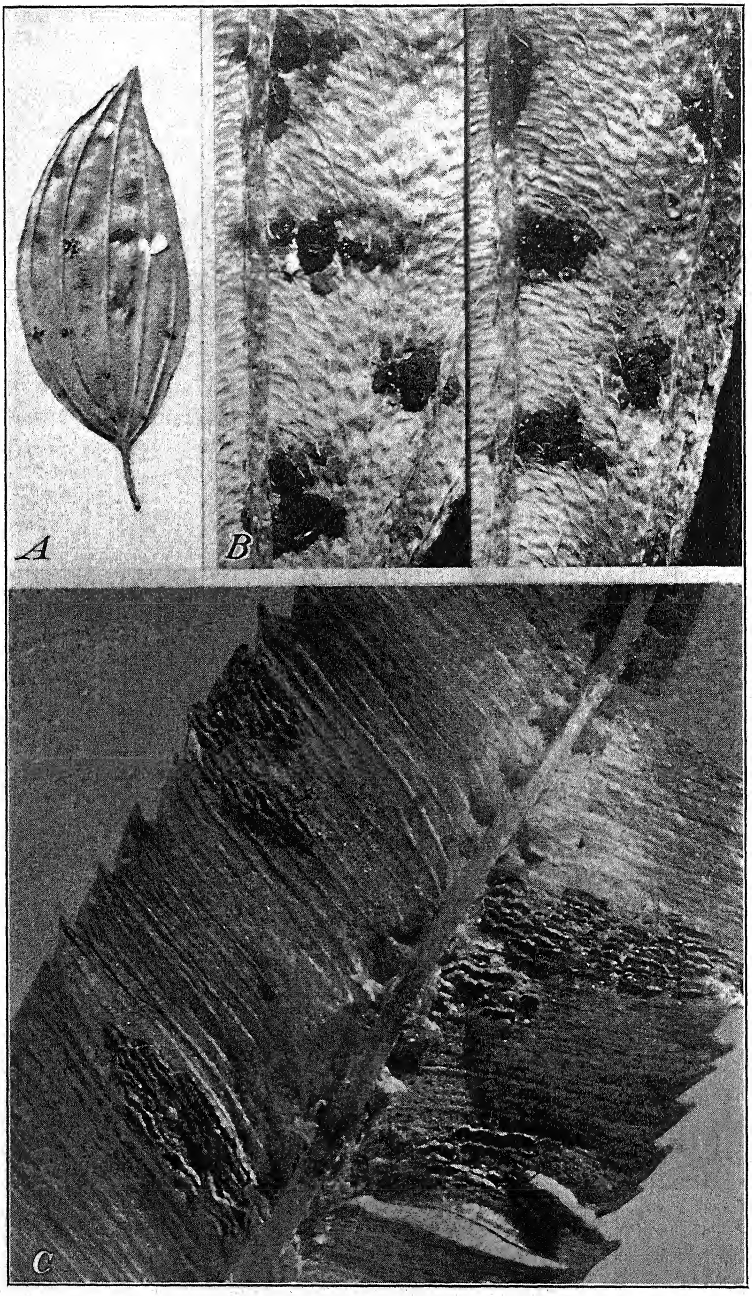

FIG. 3

low mazaedium; hypothecium golden yellow, plectenchymatic, extending deep into the host tissue, outer layer thin, composed of small, thin-walled cells, adnate to host tissue at the sides.

On *Blechnum serrulatum*[6] Rich., Itanhaen, São Paulo, Brazil, H. P. Krug, A. E. Jenkins and A. S. Costa, May 11, 1936, Inst. Agr. Campinas Herb. Secc. Phytopath. no. *1561*. Type material also in the Mycological Collections of the Bureau of Plant Industry, Washington, D. C.

Apothecia hypophylla, subepidermicalia, elliptico-disciformia, 0.5–1 mm. longa, 0.5 mm. lata, in lineis parallellis disposita, et maculas nigrifactas 3–5 mm. longas, 1–3 mm. latas formantia, longitudinaliter scindentia et hymenium alutaceo-citrinum, siccum atrobrunneum, epidermide lacerato undulati circumdatum patefacientia; asci cylindrici, basim et apicem versus attenuati, 75–90 μ longi, 10–13 μ lati; ascosporae irregulariter 1–2-seriatae, uniseptatae, late fusoideae vel biconicae, 15–18 μ longae, 7–9 μ latae; paraphyses hyalinae, filiformes, apice flavae, coalescentes; hypothecium aureo-flavidum, plectenchymaticum; cortex tenuis, lateraliter ad epidermidem adnatus.

According to the Saccardian classification, this fungus would be placed in the genus *Diplonaevia,* since the spores show a definite median septum. It is pointed out by Nannfeldt (9, p. 191) that little dependence can be placed upon the variable character of spore septation in delimiting genera in some groups of discomycetes; he therefore includes in his genus *Laetinaevia* various species of *Diplonaevia* and *Phragmonaevia* having septate spores.

SUMMARY

Maireella maculans Sydow (1908) on *Mikania hirsutissima* DC. was rediscovered at Alto da Serra, São Paulo on Jan. 12, 1936, by Krug and Jenkins. This is the type locality for the species so named, for which the genus *Maireella* Sydow was established. To the synonymy of the fungus, now known as *M. bertioides* (Sacc. & Berl.) Maubl., is added *Dimerosporium aeruginosum* Wint., based on a specimen collected at São Francisco, Santa Catharina, by Ule. *Parodiella caespitosa* Wint. and *Lizonia Uleana*

[6] Identification by W. R. Maxon, U. S. National Museum, Washington, D. C.

FIG. 3. *A–B, Dermatea parasitica* on Melastomataceae, *A*, × 1, *B*, × 8; *C, Laetinaevia Blechni* on *Blechnum serrulatum,* × 8. Photographs by Foubert.

Sacc. & Sydow, which Maublanc placed as synonyms of *M. bertioides,* were also described from specimens from this same source.

Additional records of this pathogenic species are available as a result of examining certain phanerogamic herbarium material of *Mikania* spp. These are from southern Brazil and in one instance from Costa Rica. Moreover, *Achorella costaricensis* F. L. Stevens on *Mikania* sp. from Costa Rica is identified as probably this species of *Maireella, M. bertioides.*

Setae of both *Maireella bertioides* and *M. melioloides* including a branched setum of the latter, described by Maublanc, are represented photographically. These are the only species in the genus as monographed by Maublanc.

A second species of *Achorella* described by F. L. Stevens, viz., *A. guianensis* on *Mikania* sp. from British Guiana, is transferred to the genus *Maireella* by the senior author. *Uleodothis andina* Chardon on *M. Ruiziana* from Colombia, which was described somewhat later than *A. guianensis* and which was recently transferred to the genus *Maireella* by Petrak, appears to be similar to *M. guianensis.*

Haplosporella Justiciae on *Justicia* sp. was also collected at Alto da Serra. Formerly this fungus was known only from the Amazon region, where it was discovered by Ule in 1902. Petrak and Sydow, studying Ule's specimen, reported in 1912 that the fruit layer in this specimen was of indefinite character and that the name *H. Justiciae* P. Henn. should therefore be dropped. The more recent gathering from Alto da Serra is unfortunately in no more favorable fruiting condition.

Dermatea parasitica (Wint.) Hoehnel, described from material found in Santa Catharina by Ule in 1883 and also collected by Puiggari in Apiahy, 1882–1888, was found by Krug, Jenkins and Costa at Itanhaen in 1936 on leaves of Melastomataceae.

The other of the two Discomycetes collected at Itanhaen occurs on *Blechnum serrulatum;* this appears to be new and is described by the third author as *Laetinaevia Blechni.*

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A NEW UREDINELLA FROM CEYLON

John N. Couch

(with 12 figures)

The genus *Uredinella* was described in 1937 (Mycologia **29**: 665) from rather scanty material collected by the writer in South Carolina. Soon after this paper appeared, Mr. T. Petch sent me two fine collections of this genus from Ceylon and recently Dr. George Weber has sent from Florida an abundant collection of the original species. The purpose of this paper is to describe the new species from Petch and to present some new information about the old one.

Uredinella spinulosa Couch & Petch, sp. nov.

Maculae minutae, 0.8–1.8 mm. diam., orbiculatae, effusae, annuae ad folias arborum frondosarum, facile separabiles; colore griseo-castaneo vel brunneo; contextu firmo, sicco, 50–270 μ crasso. Teleutosporae globosae vel pyriformes, brunneae, circa 15–21 μ, germinantes apice forameni distincto et formantes cylindricum, 3-septatum basidium, 6.3–7.5 × 63–72 μ; sterigmata 7 μ, sporae curvae, ellipticae 4.6–5.4 × 21–23 μ. Sporae similes teleutosporis sed cylindricae, etiam formatae, quae longe ellipticas parce curvas sporas generant. Hymenium cum setis, 9.2–14.7 × 130–230 μ.

Hab. supra Coccidas supra folias Psychotriae sp. Ceylon.

Forming minute, circular, flat patches, 0.8–1.8 mm. wide on the upper and lower surfaces of living leaves of *Psychotria* sp., always overgrowing and parasitic on a scale insect. Easily separable from the leaf. Color chestnut brown toward outer part, grayish near center due to formation of hyaline allantoid spores. Margin sharply determinate, about 80–100 μ wide, only a few threads in thickness, very pale brownish. Texture firm, dry, brittle. Surface smooth, velvety and even except for a distinct mound over the insect. In section up to 250 μ thick through center of insect, 50–105 μ thick beyond insect and to marginal region where hymenium is single, 160–170 μ thick where hymenium is stratose or double layered; composed of a hymenium and a subiculum, the latter made up of compactly arranged septate, brownish hyphae, 4.5–5.5 μ thick, which extend radially. Hymenial cells of two

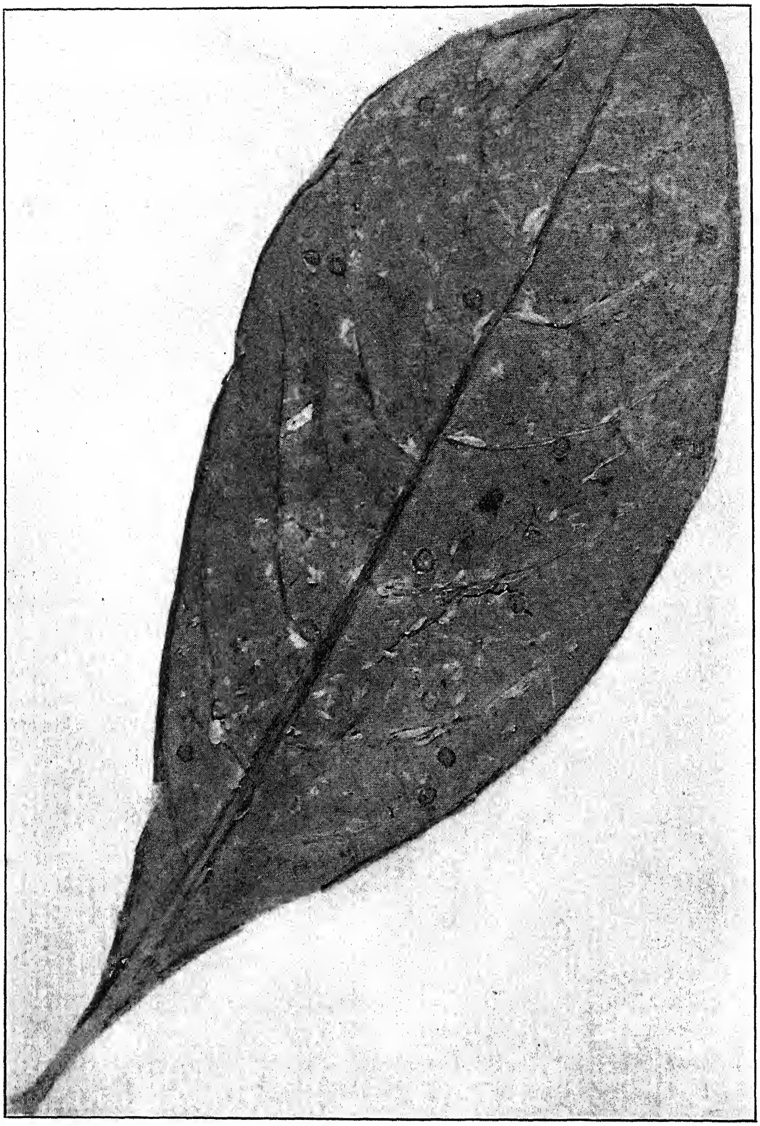


FIG. 1. *Uredinella spinulosa.*

kinds: one is a deep brown, thick-walled, spherical or pyriform teleutospore, the other an elongated, somewhat thinner-walled, brown teleutospore-like structure which gives rise to an allantoid spore. These two types of spores may be formed on the same or

on separate thalli. When found on the same thallus, the two types of cells intergrade into one another in regard to shape and thickness of wall. Spherical teleutospores are usually not arranged in a compact hymenium; 15–21 μ thick, smooth or with very minute warts at apex and distinct apical germ pore; also with stalk cell which remains attached to teleutospore even when thallus is crushed and spores are separated from thallus. Basidia apparently arising from spherical or pyriform teleutospores (none seen attached), cylindrical, 4-celled, with pointed apical cell, 6.3–7.5 $\times$ 63–72 μ, sterigmata about 7 μ long. Basidiospores bent-elliptic, hyaline, smooth, 4.6–5.4 $\times$ 21–23 μ. The elongated teleutospore-like cells are arranged in a compact hymenial layer. These spores are club-shaped and thickest at the apex or not infrequently they may be thickest at the base, and smooth or very minutely warted at the apex. Due to the thinner wall the germ pore is less distinct than in the spherical teleutospore; 8–12.6 $\times$ 29–42 μ, without a separate stalk cell; germinating to form an allantoid hyaline spore, 3.8–5 $\times$ 45–58 μ. Intermingled with both types of resting spores are numerous, thick-walled, dark brown, blunt tipped, unbranched, and non-septate setae, 9.2–14.7 $\times$ 130–230 μ. The setae may be scattered over the entire thallus but are usually more abundant over the insects.

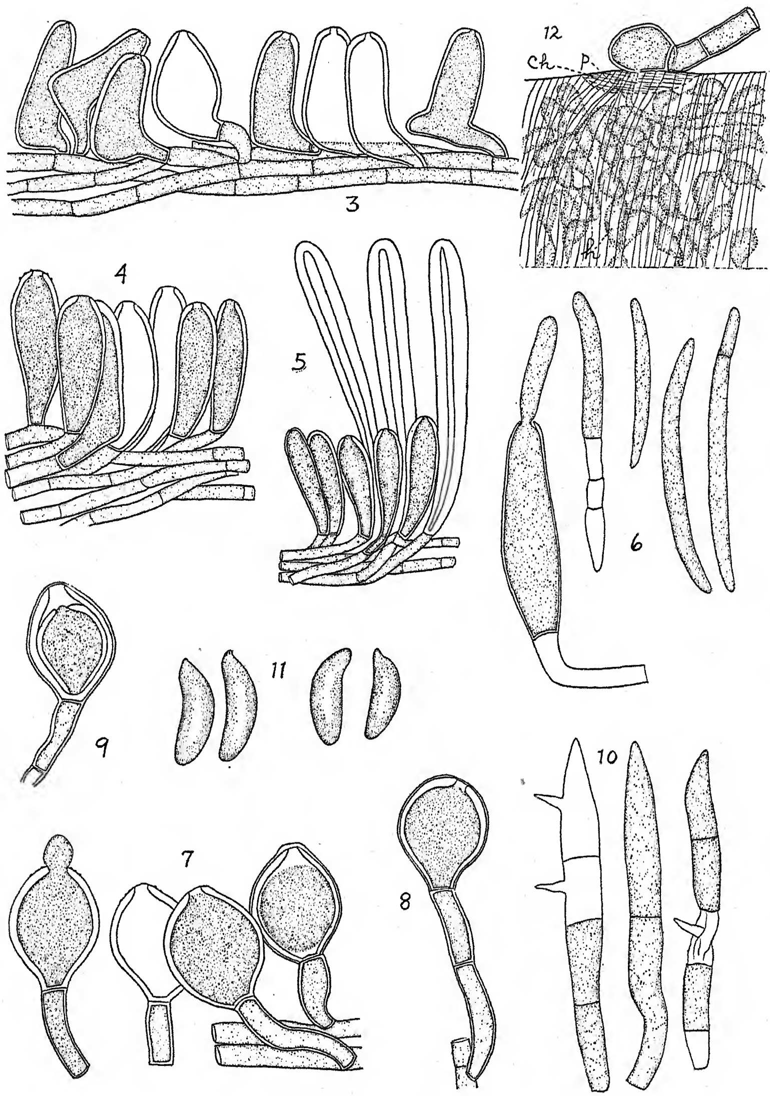
Associated with scale insects (*Aspidiotus* sp.), one parasitized insect being beneath each patch of fungal growth. Haustoria irregularly coiled and composed of sausage-shaped segments. Penetration apparently directly through insect's skin.

Ceylon: Nuwara Eliya; on leaves of *Psychotria* sp., parasitizing scale insects; August 28, 1926. Again on same host January 16, 1927. T. Petch coll. Type in University of North Carolina Herbarium and British Museum, London.

This fungus is easily recognized as a species of *Uredinella* and may be distinguished from *U. coccidiophaga* by its small size, occurrence on leaves, smooth or minutely warted, globose to subglobose teleutospores, and above all by the conspicuous spines. The haustoria and penetration through the derm rather than in the mouth region are also distinctive.

In *Uredinella coccidiophaga* the allantoid spores were binucleate and arose from binucleate cells. The allantoid spores were considered homologous to uredospores and the cell which gave rise to this spore was called the uredospore mother cell. It has not been possible in the material from Ceylon to determine if the allantoid spore

FIG. 2. *Uredinella coccidiophaga.*



FIGS. 3–12. *Uredinella spinulosa.*

is binucleate when formed or if it arises from a binucleate cell. We may assume, however, that the allantoid spores in the two species are homologous. In *U. spinulosa* the allantoid spore becomes several times septate, some of the partitions becoming empty.

On January 10 I received from G. F. Weber, Gainesville, Florida, an abundant collection of *U. coccidiophaga* growing on scale insects on *Myrica cerifera.* This fungus was originally described as growing in discoid patches 0.2–1.5 mm. wide. The patches in the Florida material, however, were much larger, varying from 1.6–3.8 mm. wide. They were also so abundant as to show up conspicuously even without magnification. The patches were circular or irregular in outline with a nearly smooth or more frequently minutely cracked surface, without setae. The basidia and spores were exceedingly abundant in this material and typical.

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EXPLANATION OF FIGURES

FIG. 1. *Uredinella spinulosa* on *Psychotria.* The circular darker spots are the fungus; the elongated whitish bodies are the scales of unparasitized insects. × 2. FIG. 2. *Uredinella coccidiophaga.* Coll. by G. F. Weber, Fla. Two pieces below, x n. s.; one piece above, × 2. Small, dark, rounded patches are the fungus. Each patch covers one parasitized scale insect. Some of the larger patches are composed of two, three, or even more small patches. On lower right of piece to right is *Septobasidium castaneum* and on upper right of piece to left is *S. sinuosum.* FIGS. 3–12. *Uredinella spinulosa.* 3, 4, hymenia showing elongated teleutospore-like cells × 585; 5, hymenium with setae, × 367; on left 6, elongated thin-walled teleutospore-like cell germinating to form allantoid spore, × 635, on right four allantoid spores, one of which has become septate, × 585; 7–9, spherical to pyriform teleutospores, each with stalk, distinct germ pore and thick wall, in 9 is shown what appears to be internal proliferation of new teleutospore within wall of old, × 635; 10, basidia, note sterigmata and pointed distal end of basidium, × 635; 11, basidiospores, × 635; 12, showing where fungus had penetrated (*p*) insect's derm, chitinous (*ch*) deposit around first cell formed, and haustoria (*h*), × 635.

NOTES ON COPRINUS MICACEUS GROWING IN AN UNUSUAL HABITAT

S. M. Pady

The conditions which permitted *Peziza domiciliana* to develop during the winter of 1937–38 [1] were also favorable for the growth and development of *Coprinus micaceus,* during the winter of 1938–39 and 1939–40. The mushrooms appeared in exactly the same locality, on the floor of a room in a residence, in a narrow strip ½″ wide and 9″ long, bounded by linoleum on one side and a porcelain fixture on the other, and the same room conditions of temperature, light and moisture prevailed. Observations were begun in the fall of 1938 at about the time the first ascocarps of *P. domiciliana* had previously appeared. Ascocarps, however, did not appear at this time nor at any time during the winter or spring. On January 25th, 1939, three mushrooms were observed, two being old and withered, and one in an active stage of growth. This fungus, which proved to be *Coprinus micaceus,* was present almost continuously until late spring. Growth was resumed in October, 1939, and continued throughout the winter and spring. The mycelium of *Peziza* had either died out or had been crowded out, because no apothecia have since appeared.

Table I shows the number of specimens which appeared from January 25th, 1939 to March 27th, 1939. The number of mushrooms maturing at one time was not large, usually one or two. Higher numbers were not common although sometimes they did occur, as for example 4 on October 26th, 1939, 5 on November 12th and 5 on December 11th. The total number of mushrooms which appeared during this particular time (October 13th to December 12th) was 35, indicating apparently optimum conditions. Growth periods were generally followed by a resting period. The two resting periods shown in Table I were approximately 14 days

[1] Pady, S. M. Observations on the rate of growth of ascocarps of *Peziza domiciliana.* Mycologia 31: 53–55. 1939.

in length. At other times the resting period was shorter, twice being recorded for 7 days. In general these resting periods which incidentally showed no periodicity in their occurrence, lasted from two to three weeks.

TABLE I

SHOWING NUMBERS OF SPECIMENS OF COPRINUS MICACEUS AND STAGES IN THEIR DEVELOPMENT

Date	Buttons	Developing	Mature	Date	Buttons	Developing	Mature
Jan. 25	?	?	1	Feb. 25	3	3	—
Jan. 26	3	—	1	Feb. 26	—	6	—
Jan. 27	1	2	—	Feb. 27	1	6	—
Jan. 28	1	1	1	Feb. 28	—	6	1*
Jan. 29	1	1	—	Mar. 1	—	4	3
Jan. 30	1	—	1	Mar. 2	—	—	—
Jan. 31	1	—	—	Mar. 3	—	1	3
No development during this period				Mar. 4	—	1	1
Feb. 15	5	—	—	No development during this period			
Feb. 16	3	2	—	Mar. 20	2	—	—
Feb. 17	3	2	—	Mar. 21	1	1	—
Feb. 18	3	1†	—	Mar. 22	1	1	—
Feb. 19	3	1	—	Mar. 23	1	—	1
Feb. 20	5	1	—	Mar. 24	1	—	1
Feb. 21	5	1	—	Mar. 25	—	1	—
Feb. 22	5	—	1	Mar. 26	—	—	—
Feb. 23	5	—	1	Mar. 27	—	—	1

* Removed for study.
† Died.

In most cases notes and measurements were taken at approximately the same time each evening; however, more frequent observations were made sometimes in order to make a more detailed study of the rate of growth. At certain times the maturing sporophore seems to grow more rapidly, as in mushroom No. 2 (Table II) when the increase in height between February 27th, and 28th was 57 mm. as compared with an increase of 12 mm. the previous day and 15 mm. the following day. In this mushroom the additional measurements give a more detailed picture of the growth rate during this period. Considerable variation was observed in the height of mature specimens, ranging from 40 mm. to 110 mm. Almost as soon as the mushrooms had shed their spores they began to wilt, the pileus withered and in a few hours the mushrooms had collapsed. Deliquescence was rare due probably to the high tem-

peratures although in some cases the outer portion of the pileus deliquesced; in most cases the mushroom simply dried up.

Although *Peziza* and *Coprinus* had appeared in the same locality and under the same conditions, differences soon became apparent. In the former many incipient apothecia appeared, of which only 2 or 3 would mature; in the latter only a few buttons were developed, but practically all matured. The time required for a single fructification to reach maturity was approximately 21 days in the case of *Peziza,* as compared with 5–7 days for *Coprinus.* Fruiting was

TABLE II

GROWTH RATES OF INDIVIDUAL MUSHROOMS

No. 1

Jan. 26/39	10:30 P.M.	Small button	
27	10:30 P.M.	Button	
28	10:30 P.M.	4–5 mm. above floor	
29	8:30 P.M.	12 mm. above floor	
	12:30 A.M.	14 mm. above floor	
	10:30 P.M.	18 mm.	Pileus 15 mm. high
30	9:30 A.M.	35 mm.	
	5:30 P.M.	65 mm.	
	9:30 P.M.	78 mm.	Pileus 25 mm. high, 32 mm. wide
31	9:30 A.M.	110 mm.	Pileus flattened, 45 mm. wide
	10:30 P.M.	collapsed	

No. 2

Feb. 24	10:30 P.M.	Button	
25	11:30 P.M.	3–4 mm.	
26	11:30 P.M.	5–6 mm.	Pileus 10 mm. wide
27	11:30 P.M.	18 mm.	Pileus 14 mm. wide
28	11:30 P.M.	75 mm.	Pileus 35 mm. wide
Mar. 1	10:30 P.M.	90 mm.	
2	10:30 P.M.	removed	

thus protracted and continuous, while in *Coprinus* the fruiting periods were intermittent, due no doubt to the depletion of food resources by the rapidly growing mushrooms.

It has been difficult to determine the source of the moisture supply. The room was heated by a burner using Texas natural gas and thus the moisture content, as well as the temperature, was maintained at a high level. This heated moisture-laden air, on striking the cold water pipes and a cold water container, resulted in considerable condensation. Since only a small fraction of this moisture dripped into the crack where the fungi were growing, it was evident that there was some other source of moisture. There

was very little evidence of rotting wood except in the crevice itself. In June, 1940, the linoleum was removed and the plumbing checked. It was discovered that there was a poor connection in the water pipe just at the floor level which allowed a small but apparently constant amount of water to be lost. A small area in the hardwood flooring, approximately 9″ × 2″, was rotted through but beyond this point the moisture had caused a very superficial rotting of the floor under the linoleum in a circular area with a radius of about 2′. The rotted wood when removed was found to be standard oak flooring. Since no plumbing repairs had been made for the last five years, and possibly longer, and since fungi were observed there in the fall of 1937 it would appear that the amount of moisture had been sufficient to maintain an ideal substratum for a limited fungus population over a period of several years.

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THE GENERA OF THE BOLETACEAE [1]

Walter H. Snell

(with 1 figure)

Even though new classifications of any group of fungi are looked upon with hearty disfavor in certain quarters and are to be deprecated under any conditions unless such changes are quite necessary, it has for some time been obvious that certain changes in the arrangement of the *Boleti* are desirable. The scheme most widely used in Europe and America up to quite recently has been the one including four genera, as follows: *Gyrodon, Strobilomyces, Boletinus* and *Boletus*. The first two genera have contained only one species each, *Boletinus* has had 12 and *Boletus* about 150 species distributed in 13 subgroups. This arrangement is comfortable because of long usage. It has been at all usable, however, only because *Gyrodon lividus* has not been found on this continent, *Strobilomyces strobilaceus* is readily recognized, and because most of the species of *Boletinus* are either likewise readily recognized, or with some degree of facility segregated from the species of *Boletus* by a single character. On the other hand, the more the group is studied and the more new species are found, the less sensible and the less practicable the scheme becomes.

In this country thus far, the genus *Gyrodon* has been dismissed as entirely European. The likewise monospecific *Strobilomyces* has been characterized as having tubes not easily separable from the flesh, pileus and stipe variously and more or less scaly, flesh tough, and spores globose, brown and reticulate. Other than the spores, these characters are not definitive. The single species of the genus is fundamentally black and thus it is easily recognized, but blackness is not a valid generic character.

The characters now used to distinguish the genus *Boletinus* read well and sound convenient, but at least one of them is not even

[1] This paper is essentially the same as the one read at the meetings of the National Academy of Sciences at Brown University, October 25, 1939 (see Abstract in Science N.S. 90, 2340: 412. Nov. 3, 1939).

valid. The tube-layer of some species is about as easily separable from the flesh as any of the species of *Boletus,* and on the other hand, the tube layer of many species of *Boletus* is separable with as great difficulty as in some of the species of *Boletinus.* The tubes of most *Boletini* are compound but those of many species of *Boletus* also are. The best character is the radial arrangement of the tubes and especially the more or less complete presence of radial veins or lamellae, at least near the stipe. In this particular, however, we have difficulty. Peck (7), for example, placed the species *spectabilis* in *Boletus,* but he said (6) that this species along with *Boletinus pictus* and *B. paluster* formed a natural group. Murrill placed *spectabilis* in *Boletinus* (5), because the tubes are occasionally radiately arranged. Some collections, however, will not show this character at all. More recently two collections sent in from the Pacific Coast gave considerable trouble in attempts at identification, because they were decidedly boletinoid in this respect, but they plainly turned out to be *Boletus Lakei.* Again, there is the case of what Peck described as *Boletus amabilis,* with a note that " the tubes have a radiating structure as in the genus *Boletinus*" (8, p. 612) but that he desired to obtain more data before placing it there. Some species of *Boletus* are obviously very close to *Boletinus.* In fact, the subgroup Viscipelles of the genus *Boletus* and *Boletinus* run together at several points.

The genus *Boletus* is certainly a conglomerate of groups of species (Peck's tribes), which differ more from one another than the Viscipelles do from *Boletinus.* For example: Viscipelles (*B. granulatus, B. americanus, B. luteus, B. piperatus,* etc.), with viscid to glutinous pileus, small, elliptical and hyaline to yellow or greenish spores; Calopodes, Luridi and Edules, with bulbous stipe for the most part, yellow tubes and subfusiform spores mostly yellow under the microscope and ochraceous to brownish in mass; Versipelles (*B. scaber, B. versipellis, B. aurantiacus,* etc.), with white tubes, relatively long, scabrous stipe, and large, more or less naviculate, brownish spores; Cariosi (including *B. castaneus* and *B. cyanescens*), with imputrescible carpophore, tubes white becoming yellow, hollow stipe, spores short-elliptical, hyaline, and yellow in mass. Not only do these subgroups differ greatly one from another, but they may be of different phylogenetic origins, as witness

Roger Heim's statement that the Boletaceae in the Friesian sense are ". . . un groupement artificiel de formes à convergence hyméniale, en réalité d'origines très diverses . . ." (2, p. 19).

In this situation, which is becoming more unsatisfactory the more one studies the *Boleti,* if one is not to remain a slave to usage some change is desirable, if not absolutely necessary upon phylogenetic grounds. There are three sorts of change possible. One is to retain all the species in one genus *Boletus,* as has been done by Sartory and Maire (**10**).

The second possibility is dismemberment and increase in the number of genera—especially, division of the genus *Boletus* along lines that have already been used for decades or as may appear justified by further study. This treatment for the most part involves the raising of the various subdivisions of *Boletus* made by Fries and elaborated by Peck to genera, in a more or less complete fashion.

The third possibility is in the nature of a compromise—to accept some of the subgroups as distinct genera and others as subgenera of the genus *Boletus.*

The first arrangement would probably satisfy no one. It would not only be a change from present practice, but it is not consonant in any way with mycological progress in the past hundred years to include in a single genus species with all sorts of superficial characters and with all sorts of form and ornamentation of spores, to say nothing of their colors, and hence to consider the fleshiness of the carpophore and the tubular nature of the hymenophore as the only definitive generic characters. Such an arrangement would offer no advantages in the identification of species. Further, if by any chance the family is a convergent group representing different phylogenetic origins, a single genus would be ridiculous.

Of several schemes of dismemberment proposed in the last 40 years, only one has been promulgated on this side of the Atlantic—that by Murrill (**5**) based more or less on that of Karsten (**3**). This scheme consists of 11 genera, 4 of them new. The genus *Boletus* is split into 8 genera (3 new) largely on the basis of color of the spores in mass, and presence or absence of glandular dots and annulus on the stipe. Not only have these characters not been considered as valid for generic segregation by any student of

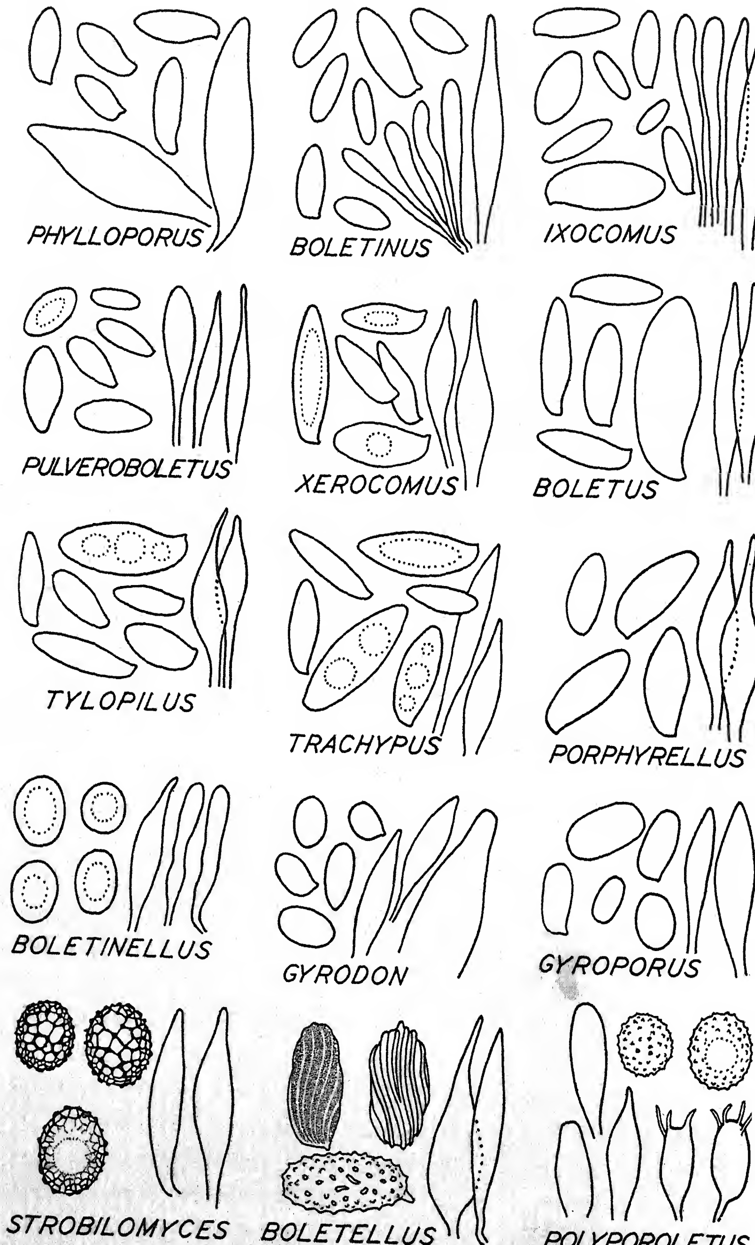

FIG. 1. Typical spores and cystidia of the genera of the Boletaceae, with basidia for *Polyporoletus*. Spores × 1000, cystidia and basidia × 500.

the group, but further the result of their use is 7 small genera and a hodgepodge genus, *Ceriomyces,* containing 48 of the 80 species in his family. Three of Murrill's new genera, however, are acceptable.

Of the several other new schemes proposed in Europe, only one has had any substantial recognition in recent years—that of Gilbert (1), in turn a modification of that of Quélet (9). After long and troubled cogitation upon the subject, the writer has been impelled to bring himself to the adoption of this scheme in all but a few details. Unanimous acceptance of this proposal in this country there certainly will not be, but for conscientious objectors on grounds of long-established usage, or of constitutional dislike of "revisions," there is easy escape—the adoption of the scheme of Konrad and Maublanc [possibility three above (4)]. Those who insist upon retaining the present scheme of four genera can merely reduce the new genera to subgenera to parallel the Friesian-Peck arrangement in use at present. The change from any one of these schemes to any other would be simple.

For the present writer, then, the Boletaceae will be made up of subfamilies, subgroups and genera characterized by a combination of gross features of the carpophore and spore morphology (see figure 1 for illustrations of the spores and cystidia). The arrangement follows:

Subfamily BOLETEAE—with smooth spores.

EUBOLETEAE—with hymenophore lamellate, boletinoid or tubulate, with tubes compound or simple, and spores long-elliptical or subfusiform and colored.

Genus 1. *Phylloporus* Quélet, consisting of the single species, *P. rhodoxanthus.*

This genus appears to the writer to be a good one and seems to be better placed in the Boletaceae than with the Paxilli. It has the superficial appearance of a bolete, and is invariably picked casually as one, and in addition to the anastomosing lamellae, it has definitely boletoid spores and cystidia.

Singer (11, pp. 169–170) has placed in this genus one species (*squarrosoides*) which the writer still retains in *Boletinus,*

at least until further studies can be made of the boletinoid species.

Genus 2. *Boletinus* Kalchbr.—as now constituted, except for the segregated genus *Boletinellus,* and such species as may be added to it from the following genus, with tube layer more or less lamellate and tubes more or less radiately arranged, and with spores narrowly elliptical and thin-walled.

Genus 3. *Ixocomus* Quélet—the Viscipelles of Fries and Peck, with viscid or glutinous pileus, compound tubes not radiately arranged and not at all separated by lamellae, and spores narrowly elliptical.

Genus 4. *Pulveroboletus* Murr.—the Pulverulenti of Peck (*B. hemichrysus, B. Ravenelii* and *B. auriflammeus*), with surface of pileus and stipe more or less pulverulent, tubes simple, and spores small, ellipsoid to ovoid.

It may be that this genus will be better established when more is known about the presence or absence of a veil and its connection with the pulverulence.

Genus 5. *Xerocomus* Quélet—the Subpruinosi and Subtomentosi of Fries and Peck, which groups the writer finds useful enough to retain as subgroups of the genus.

The surface of the pileus is dry, never viscid, and glabrous, subpruinose or subtomentose; the tubes are compound or simple as far as studied; the spores are subfusiform. The stipe is never reticulate or subbulbous and the tubes are never stuffed or with red mouths, as in the groups of *Boletus.*

Genus 6. *Boletus* Dill. ex Fries—including the Calopodes, Edules and Luridi of Fries and Peck, which will be retained as subgroups, as they have been by Gilbert (**1**) and by Konrad and Maublanc (**4**). Other than the distinctive characters of these subgroups (reticulate stipe and adnate tubes, stuffed tubes, and red tubemouths, respectively), the genus is in general characterized by sporophores rather stout and robust, tubes simple, stipe stout and more or less bulbous, especially at first, and spores subfusiform.

Genus 7. *Tylopilus* Karst.—the Hyporhodii of Fries and Peck. Gilbert (**1**) rejected this genus on the ground of insufficiency of distinguishing characters, which are solely the flesh-colored tubes and spores. Konrad and Maublanc, however, accepted the genus. There is no gainsaying Gilbert's logic, but the writer is inclined to include the genus because of the ease with which it can be recognized and also because such a segregation reduces the bulk of the genus *Boletus*.

Genus 8. *Trachypus* Bataille (for the preëmpted *Krombholzia* Karsten, and as having priority over *Krombholziella* R. Maire)—the Versipelles of Fries and Peck, with tubes white, at least at first (or possibly yellow if *rugosiceps* is included), stipe more or less slender and tapering and scabrous, and spores in general more or less naviculate.

Genus 9. *Porphyrellus* Gilbert—for the pilose, reddish-spored *B. porphyrosporus* and *B. fumosipes,* formerly of the Favosi.

GYRODONTEAE—with hymenophore more or less boletinoid and more or less lamellate, tube layer thin (tubes short to very short), and spores small and oblong to short-elliptical or nearly subglobose, colored.

Genus 10. *Boletinellus* Murrill, a segregate from *Boletinus,* with very lamellate, merulioid hymenophore and very broadly elliptical, thick-walled spores, including *B. merulioides* (*porosus*) only.

Singer (**11**, pp. 37 & 171) combined this genus with *Gyrodon* and perhaps rightly so, but for the present at least, it is being kept distinct by this writer.

Genus 11. *Gyrodon* Opat.

Until quite recently, this genus has included only one species (*lividus*) growing under alders in Europe. Singer (**11**) recently placed *Boletus sphaerosporus* Peck here because of the spores, and made a new subgenus *Paragyrodon* for it. The writer was for some time inclined to erect a new genus for this and three other species with very small, short-ellipsoid

spores like those of *Gyrodon,* because our species do not seem to be imputrescible, the tubes are not unusually short nor consistently large, the stipes are not always slender nor do they enlarge particularly into the pileus, and clamps have not with certainty been found, but he now believes it would be better to place them in *Gyrodon.* These other species are: **G. californicus** (Murr.), *comb. nov.,* **G. Ballouii** (Peck), *comb. nov.,* **G. tennesseensis** Snell & Hesler, *comb. nov.,* and **G. Housei** (Murr.) *comb. nov.*

LEUCOSPORELLEAE—with carpophore imputrescible, hymenophore tubulate, tubes simple, at first white and then usually yellow, stipe customarily becoming hollow, and spores white or yellow in mass, small, hyaline, oblong or short-elliptical.

Genus 12. *Gyroporus* Quélet—the Cariosi.

Subfamily STROBILOMYCETEAE—with ornamented spores.

Genus 1. *Strobilomyces* Berk.—as heretofore, with globose, reticulated spores.

Genus 2. *Boletellus* Murr.—with spores large, elliptical, longitudinally striated or wrinkled, or verrucose, including *B. Ananas,* the Laceripedes (*B. betula* and *B. Russellii*), **B. chrysenteroides**, and **B. subflavidus** (Murr.) *comb. nov.*

Genus 3. *Polyporoletus* Snell—the polyporoid *P. sublividus,* with spherical, verrucose spores.

Extra-limital genera of Boleti are as follows: the tiny Javan *Filoboletus* Henn.; the huge Madagascan *Phlebopus* Heim; and the Cameroonian *Fistulinella* Henn. and the Madagascan *Ixechinus* Heim, both of the latter with discrete or fistulinoid tubes.

The writer is not yet ready to follow Gilbert completely. This estimable French mycologist has erected a new order Boletales (1), arranged as follows: suborder Boletineae, with the families Paxillaceae (genus *Paxillus*), Boletaceae (other genera than noted here), Leucosporellae (*Gyroporus*) and Gyreae (*Gyrodon* and *Boletinellus*); suborder Strobilomycetineae, family Strobilomycetaceae (*Boletellus* and *Strobilomyces*). In this scheme there is more subdivision into families than American mycologists wish to digest for

the present, although there is much to be said for placing the Paxillaceae near the Boletaceae.

This new classification proposed for adoption is not perfect. There are more monospecific genera than might be desired. There are some species that appear to cross generic lines and one or two genera that appear to be composite and perhaps unnatural, but further rearrangements will without doubt iron out many of the discrepancies, especially upon the completion of studies of microscopic details and ontogenetic development, possibly chemical or even serological studies, etc. It is to be expected that there would be more difficulty in fitting our 160-odd species into any framework than it is for the Europeans with about 50 species. On the other hand, the scheme is more sensible and more in accord with modern concepts. It is believed that the spore characters are more fundamental than some of the superficial, macroscopic features now used as a basis of classification, and while amateur mycologists without a microscope may not be so well served as formerly, the family is on a sounder foundation and accurate identification of species will be facilitated.

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DATA ON THE CULTURAL CHARACTERISTICS OF A SPECIES OF COPRINUS

G. T. JOHNSON [1] AND ASA C. JONES

INTRODUCTION

In 1928, Frear, Styer, and Haley published a study of the effect of hydrogen-ion concentration on the growth of *Agaricus campestris*. Even at that late date the authors could state (p. 91), "Very little investigational work has been done on the growing of mushrooms in artificial media." The statement is still true as far as field mushrooms are concerned. Both generic and specific cultural requirements of members of the group vary a great deal, and the writers hope that the facts obtained during the culture of a *Coprinus,* and reported below, will be of interest in this regard.

MATERIALS AND METHODS

The organism studied was isolated in 1936, by the senior author, from soil collected in Costa Rica by Dr. C. W. Dodge.[2] Pure cultures of the plant were utilized in experiments designed to measure the effect of different cultural conditions upon its growth. The amount of mycelium (dry weight) produced in nutrient solution and the number of sporophores (actual count) developing per culture were taken as the criteria by which the extent of growth could best be measured.

Unless otherwise specified all experiments were carried out in specially cleansed 300 ml. Erlenmeyer flasks, in each of which 50 ml. of the solution to be tested had been placed. The formulae of these solutions are given in connection with each experiment reported. Substances used in nutrient solutions were of the highest purity and all media were autoclaved at 15 pounds pressure for 15 minutes.

[1] Fellow of the John Simon Guggenheim Memorial Foundation

[2] The organism is closely related to or identical with *Coprinus cubensis* Berk. & Curt. Its development has previously been described (Johnson, 1941).

Stock cultures were maintained on potato-dextrose agar and were allowed to produce mature sporophores. Fruit bodies produced in such cultures were removed, placed in a flask of sterile water, and rotated until a considerable number of spores were in suspension. The sporophores were then removed aseptically and the flask was shaken so as to maintain a uniform distribution of spores. Liquid media were inoculated by transferring 1 ml. of this spore dispersion to every 50 ml. of medium by means of a sterile pipette. After growth, the resulting cultures were filtered through alundum crucibles (RA360), the filtrate hastily washed with distilled water, and the dry weight of the mycelium produced was finally obtained. Solid media were inoculated with ½ cm. agar blocks, carefully cut from a Petri dish culture containing abundant and uniform mycelial growth. Hydrogen-ion concentrations were determined by Clark and Lub's indicator method, but in the experiments dealing with the effect of this factor on growth all values were checked with a Beckman glass electrode.

EXPERIMENTAL RESULTS

Periodicity of Fructification

When first isolated, the organism would fruit on potato-dextrose agar in nine days. Records were kept as to the regularity of fructification of all stock cultures, which were transferred at definite intervals, and on control cultures, which were grown on potato-dextrose agar each time an experiment was carried out. All these cultures were placed in a moderately lighted room at a temperature of $30 \pm 2°$ C. and maintained from September, 1936 to August, 1938, in Saint Louis, Missouri. During that period almost three-fourths of the cultures on potato-dextrose agar produced mature sporophores. When sporophores were produced they had always appeared by the ninth day after the inoculation of the culture, and in most cases the ninth day was the one upon which the first button of a culture expanded and began to deliquesce. Deliquesence of the first fruit body always occurred 9 ± 1 days after inoculation under the conditions mentioned above. Slight modifications could be obtained, either by placing the cultures in the dark or at a higher temperature during early stages of growth. Higher temperatures

for a day or two shortened, total darkness for a time lengthened the period required for fructification.

Elongation of the buttons into fruit bodies took place at equally interesting time intervals. Young buttons began to expand about 4:30 P.M. The peak in development was reached between midnight and 2:00 A.M., and deliquescence of the lamellae was usually completed by 8:00 A.M. of the day following the beginning of expansion. Cloudy days or the difference between day and night in winter and summer did not bring about variations greater than thirty minutes in the beginning of expansion, and conditions imposed by the writers did not modify it to a greater extent. The length of time required for total development seemed to depend upon the ultimate size of the organism, smaller plants usually maturing more rapidly than larger ones.

Effect of Temperature

Measurements of mean diameters of colonies of the fungus grown on potato-dextrose agar established an optimum temperature of 34 ± 1° C. In the same experiment all temperatures between 30–38° C. gave excellent growth. Since the thickness of *Coprinus* mycelium in such cultures varies a great deal, however, thallus dry-weight grown in liquid media has been considered a better measure of growth than mean colony diameter. Table I records the average dry weight of thallus produced five days after the inoculation of nutrient solutions containing 1 per cent peptone, ½ per cent beef-extract, and 2 per cent dextrose, at various temperatures.

Analysis of table I shows that no growth occurs at 10° or at 42° C.; that growth is fairly rapid at other temperatures between these limits and is exceptionally vigorous between 25–35° C. Under the conditions of our experiment 35 ± 1° C. is the optimum temperature for vegetative activity. The light factor involved made it difficult to test critically the temperature relation to fruit body production, but higher temperatures likewise favored abundant reproductive development. Cultures kept in rooms between 20–25° C. rarely fruited; cultures kept between 30–35° C. produced more fruit bodies per culture than did others kept between 25–30° C.

TABLE I

DRY WEIGHT OF THALLUS IN RELATION TO TEMPERATURE—*Coprinus*

Temperature ± 1° C.	No. of Flasks Inoculated	Initial pH	Final pH	Average Dry Weight (grams)
10	5	6.0	6.0	0.000
13	6	6.0	6.3	0.070
16	5	6.0	6.6	0.092
19	6	6.0	6.2	0.122
25	6	6.0	6.9	0.225
31	6	6.0	6.8	0.271
33	8	6.0	6.9	0.357
35	8	6.0	6.9	0.372
39	6	6.0	6.3	0.069
42	5	6.0	6.0	0.000

Effect of Hydrogen-ion Concentration

To test the influence of pH on the growth of this species of *Coprinus* potato-dextrose agar was prepared and titrated with acid or base to give a gradation of hydrogen-ion concentrations. Extremes were not compared because a pH greater than 9.2 or less than 4.0 would not buffer the sol. The medium was distributed in 100 ml. portions into 500 ml. Erlenmeyer flasks, sterilized, and checks tested after sterilization to obtain the initial pH value. The flasks were then inoculated with ½ cm. agar blocks containing vigorous mycelial growth and placed in an incubator (darkness) at 32 ± 1° C. At twelve hour intervals the extent, color, and type of mycelium were recorded. All media tested gave some growth, and media with initial pH values between 5.9 and 7.4 were favorable for rapid vegetative development. The optimum initial pH was 6.9. At initial pH 9.2 the mycelium was very shiny and closely pressed to the surface of the agar; all others were of a vigorous aerial type. After twenty-four hours all cultures were bright yellow in color. Cultures of high initial pH rapidly changed to a dark brown, those of lower initial pH became light brown and did not turn dark brown for five or six days. Because of variation in mycelial type and appearance the results obtained were checked by an experiment designed to measure the average dry weight of the mycelium produced after eight days growth in nutrient solutions of different hydrogen-ion concentrations. This is reported in table II.

TABLE II[3]

DRY WEIGHT OF THALLUS IN RELATION TO pH—*Coprinus*

Initial pH	No. of Flasks Inoculated	Final pH	Average Dry Weight (grams)
4.0	5	4.1	0.050
4.5	8	5.7	0.077
4.8	5	7.8	0.237
5.2	8	7.9	0.230
5.5	9	8.0	0.226
6.3	9	8.0	0.230
6.7	7	8.0	0.234
6.9	8	8.0	0.242
7.3	8	7.8	0.211
7.9	9	7.8	0.200
8.1	9	8.1	0.203

After nine days the flasks of potato-dextrose agar on which the mean colony diameter measurements had been made were brought into a well-lighted room at 30 ± 2° C. and allowed to produce mature sporophores. The first of these appeared after five additional days and production continued for a period of six days. Table III records the total number of sporophores produced at the different initial pH values of the cultures inoculated in this experiment.

TABLE III

Coprinus SPOROPHORE PRODUCTION IN RELATION TO pH

Initial pH	Final pH	No. of Normal Fruit Bodies	No. Undeveloped Fruit Bodies
4.0	6.6	16	75
5.0	6.9	10	31
5.9	7.2	18	37
6.9	7.9	23	26
7.5	7.7	13	56
8.2	8.6	10	55
9.2	8.9	13	57

All data indicate an initial pH of 6.9 as optimum both for vegetative growth and for the production of fruiting bodies. Initial pH values were changed by subsequent growth of the fungus, the pH always being raised except in the most extreme alkaline conditions

[3] The medium in this experiment consisted of 10.0 g. of dextrose and 10.0 g. of peptone per liter of distilled water. 0.1 N. H_2SO_4 and 0.1 N. NaOH were used for titrations. Solutions were prepared, autoclaved, and checks tested; the pH after sterilization was used without change to avoid a possible salt effect by the addition of both acid and base.

tested. Optimum growth was also obtained when final pH values were slightly alkaline. This species of *Coprinus* is not only tolerant to a wide range of hydrogen-ion concentrations (4.0–9.2), but in many cases it changes the pH of the substrate considerably during its growth.

Effect of Nitrogen Sources

The experiment recorded in table IV is designed to measure the dry weight of the mycelium produced after nine days growth (at $30 \pm 2°$ C.) in nutrient solutions containing different nitrogen sources. The control contained 10.0 g. dextrose, 0.75 g. $MgSO_4$, 1.25 g. KH_2PO_4, 0.25 g. KCl, 0.5 g. $CaNO_3$, a trace of $FeCl_3$, and 1000 ml. of distilled water. Nitrogen sources were added in amounts necessary to give the nitrogen equivalent of 20.0 g. of peptone per liter of solution.

TABLE IV[4]

DRY WEIGHT OF THALLUS IN RELATION TO NITROGEN SOURCES—*Coprinus*

Type of Culture	No. of Flasks Inoculated	Initial pH	Final pH	Average Dry Weight (grams)
Control	6	4.3	4.4	0.044
Tyrosine	3	4.4	4.4	0.049
Gelatine	6	4.7	4.8	0.050
$(NH_4)_2SO_4$	6	4.6	4.6	0.055
Alanine	6	4.6	4.6	0.057
Asparagine	6	4.6	4.6	0.057
Urea	6	6.8	6.8	0.064
$NaNO_3$	6	4.4	4.6	0.068
$NaNO_2$	5	6.5	6.5	0.072
Egg albumen	6	4.3	4.6	0.195
Casein	6	4.3	4.6	0.308
Peptone	6	4.3	5.0	0.326

[4] Media containing glycine and cystine were also tested. A slight amount of growth occurred in both; in fact, more than in the control. The initial pH values were so low, however, that they cannot be favorably compared with the other sources and hence they are omitted from the table. Some of the substances tested in this and other experiments were not completely soluble; in such cases all residue was left in the bottom of the culture flask. None of this material is included in the dry weight. The mycelial mat formed in these cultures was removed with forceps, placed in a flask of sterile water for washing, and finally filtered through alundum crucibles. It is possible that some weight was lost in this process, but the greatest possible precautions were taken to prevent error here.

Table V records measurements similar to those of table IV, but in this experiment all mineral nutrients were omitted and the control consisted of 10.0 g. of dextrose and one liter of distilled water. The nitrogen sources were added in the same ratio as in the previous case and the cultures were kept at the same temperature. No growth was obtained in the control or in the following: glycine, tyrosine, gelatine, cystine, $(NH_4)_2SO_4$, asparagine, $NaNO_3$, and $NaNO_2$. Since flasks containing glycine and cystine showed a very low pH, either this factor or the lack of availability of the substances for food may be the reason for lack of growth in them. The pH could not have been the important factor with the other cultures.

TABLE V

DRY WEIGHT OF THALLUS IN RELATION TO NITROGEN SOURCES—*Coprinus*

Type of Culture	No. of Flasks Inoculated	Initial pH	Final pH	Average Dry Weight (grams)
Urea	6	8.3	8.0	0.027
Alanine	6	4.6	4.7	0.036
Egg albumen	6	6.1	6.6	0.075
Casein	9	4.4	5.0	0.108
Peptone	9	6.2	7.3	0.119

Far better results were obtained with complex protein materials (egg albumen, casein, and peptone). The presence of minerals (compare tables IV and V) increased growth to a significant extent.

Effect of Carbohydrate Sources

Table VI records measurements of the effect of various carbohydrate sources on the dry weight of mycelium produced after nine days (at 30 ± 2° C.) in nutrient solutions. The control contained 10.0 g. of peptone to each liter of distilled water. Carbon sources were added in the amounts necessary to give the carbon equivalent of 20.0 g. of dextrose per liter of solution.

Miscellaneous Remarks

Attempts were made to test the effect of minerals upon growth, using media containing several mineral nutrients and intermediate

conditions lacking single ions. Solutions without ions gave no growth and complete solutions the most growth, but solutions lacking ions gave results difficult to interpret.

The species studied may be an unusual *Coprinus,* for it did not grow on horse dung. Spores did not produce visible mycelium on this substrate and inoculations from agar blocks with vigorous

TABLE VI

DRY WEIGHT OF THALLUS IN RELATION TO CARBOHYDRATE SOURCES—*Coprinus*

Type of Culture	No. of Flasks Inoculated	Initial pH	Final pH	Average Dry Weight (grams)
Control	9	6.7	8.1	0.067
Amygdalin	9	6.6	7.2	0.076
Xylose	8	3.8	7.5	0.105
Arabinose	9	4.6	7.9	0.112
Lactose	7	6.3	7.2	0.144
d-Galactose	7	5.9	7.9	0.153
Inulin	9	6.8	8.1	0.155
Sucrose	8	6.6	8.1	0.166
Raffinose	7	6.0	8.3	0.192
Dextrose	9	6.1	7.7	0.200
Maltose	9	6.4	8.0	0.210
Levulose	7	5.4	7.5	0.215
Mannitol	8	6.8	8.1	0.221
Starch	8	6.6	7.6	0.224
Dextrin	9	6.8	7.8	0.240
Mannose	8	6.0	7.5	0.255

mycelial growth simply sent from the agar into the air aerial hyphae typical of old cultures. Flask cultures on horse dung did not change appearance, but the cultures on potato-dextrose agar, kept under the same conditions, produced an abundance of fruiting bodies. Experimental conditions were not sufficiently varied, however, to assure that similar results would always occur.

DISCUSSION

There is little in mycological literature with regard to the conditions under which fruit bodies of mushrooms are produced in culture. The extreme regularity of fructification of the species studied by the writers has made it possible to present data of this kind in connection with conditions of temperature and hydrogen-

ion concentration. Optimum vegetative growth in a closed system favored quick and abundant reproductive development.

An exceptionally high temperature is indicated as optimum for mycelial growth and for the production of sporophores. Does this hold only in the laboratory, or is this indicative of the tropical habit of the organism? Optimum temperatures of species of the temperate zone are known in only a few cases; it is possible that the rarity with which temperate forms fruit in culture is due to the fact that the organisms need a temperature for that process considerably above that of the ordinary room in which preliminary experiments are usually carried out (20–22° C.).

Cultures of the fungus studied did not appear to differ in vigor at the end of two years from the cultures, freshly isolated. After four years, however, certain characteristics of the organism may have changed. The morphological characters of the fruit body have not yet altered, but the rate of growth and the percentage of cultures producing sporophores are not quite the same.

SUMMARY AND CONCLUSIONS

1. This paper contains data derived during the culture of a species of *Coprinus* (closely related to or identical with *C. cubensis* Berk. & Curt.).

2. The fungus requires an exceptionally high temperature for its optimum vegetative development (35° C.) and for the production of sporophores.

3. Regularity of fructification in culture is well established. Even under somewhat variable conditions, sporophores produced on potato-dextrose agar appeared in 9 ± 1 days.

4. Development of the fruit body is correlated with periods of the day. Young buttons begin to expand about 4:30 P.M.; the sporophores reach maturity in the early morning and old age in the late morning of the following day.

5. In nutrient solution and on potato-dextrose agar the optimum initial pH for this *Coprinus* is 6.9. It often greatly changes initial pH values, usually to a more alkaline condition, and optimum fruiting takes place at a final pH of 7.9. Extreme acid pH values are changed to less acid or to alkaline ones, while alkaline conditions

usually remain unchanged or are changed to still more alkaline ones (although some of the most alkaline have been slightly lowered) during growth.

6. The fungus does not effectively utilize nitrogen when it is applied alone, or with a carbon source (dextrose), in the form of amino-acids, urea, gelatine, or inorganic ammonium, nitrate, or nitrite salts. Better results are obtained, however, with complex protein materials.

7. When applied with a nitrogen source (peptone) the fungus showed little specificity for carbohydrate groups, although the glucoside and pentose were least efficient.

8. Failure to grow on horse dung is a striking characteristic indicating that this may be a most unusual species of *Coprinus*.

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MORE FLORIDA NOVELTIES [1]

William A. Murrill

Venenarius alliaceus sp. nov.

Pileo convexo, 8 cm. lato, albo, odore alliaceo; sporis 13 × 4 μ; stipite albo, floccoso, bulboso, 10 × 1.5–2.5 cm.

Pileus convex, about 8 cm. broad; surface white, smooth, shining, decorated with a few volval fragments, margin entire, even, appendiculate; context thin, white, unchanging, with a pronounced garlic odor; lamellae adnate, narrow, rather close, unequal, entire, white; spores sausage-shaped, smooth, hyaline, about 13 × 4 μ; stipe tapering upward, floccose, solid, white, 10 × 1.5–2.5 cm.; bulb enormous, ovoid or slightly truncate, radicate, about 4 × 3.5 cm.; volva limb 2 cm. high, partly carried aloft and the remainder collapsed against the stipe; veil thin, membranous, white, becoming more or less torn, but leaving an annulus at the apex.

Type collected under a live-oak at the Tung-oil Mill on the Newberry Road, west of Gainesville, Fla., June 18, 1938 (No. *F 16418*). A very handsome species strongly suggesting *Amanita cylindrispora* Beardslee, but having a decided odor of wild onions and being entirely distinct from *A. roanokensis* Coker, which Beardslee says is the same as his species.

Venenarius praelongisporus sp. nov.

Pileo convexo-plano, 7 cm. lato, glabro, albido, odore nullo; sporis elongatis, glabris, 9–13 × 3–4 μ; stipite pallido, 6–8 cm. longo; volva magna, alba, cupuliformi.

Pileus convex to expanded, gregarious, about 7 cm. broad; surface dry, smooth, glabrous, white or with a faint cream tint, margin even, entire; context white, without odor; lamellae adnate, narrow, close, white, becoming brownish with age or on drying, the edges remaining white; spores cylindric or oblong-ellipsoid, smooth, hyaline, 9–13 × 3–4 μ; cystidia none; stipe equal, white with a yellowish tint, squamulose above, about 6–8 cm. long and 8–12 mm. thick;

[1] The specimens cited in this paper are deposited in the Herbarium of the Florida Agricultural Experiment Station, at Gainesville.

bulb abrupt, short-radicate, about 1.5 cm. high and wide; volva flaring, white, with free limb; veil ample, white, either forming an apical annulus or becoming torn into large fragments.

Type collected by W. A. Murrill in bare soil under a live-oak in Gainesville, Fla., May 16, 1938 (No. *F 16108*). Also collected by the author under a pine in Gainesville, Aug. 23, 1937 (*F 15926*). This species differs from *V. roanokensis* Coker in being free from the odor of chloride of lime and in having no volval fragments on its cap. At first sight it suggested to me *Venenarius virosus* of Fries.

Venenarius solitariiformis sp. nov.

Pileo convexo-subexpanso, 6–8 cm. lato, albido, gemmato; sporis elongatis, 10–13 × 4–5 μ; stipite tomentoso, albo, 3–4 × 1.3–1.5 cm.; volva veloque evanescentibus.

Pileus convex to subexpanded, solitary, 6–8 cm. broad; surface dry, white stained with cream, decorated with conspicuous, sharp, gemmate warts, especially on the disk, margin even, entire; context white, without any odor of chloride of lime; lamellae just free, not rounded behind, arcuate, medium broad and medium distant, white to isabelline with white edges, few short ones; spores elongate, smooth, hyaline, granular, 10–13 × 4–5 μ; stipe short, white, floccose-tomentose, tapering upward, 3–4 × 1.3–1.5 cm.; bulb ovoid, radicate, white, without volval limb; veil evanescent, remaining in fragments on margin and stipe but forming no annulus.

Type collected by W. A. Murrill under an oak in Gainesville, Fla., Aug. 9, 1937 (No. *F 16415*). Also collected by the author under a pine in Gainesville, June 22, 1938 (*F 16515*). Resembling *V. solitarius* but having elongate spores.

Venenarius subsolitarius sp. nov.

Pileo convexo-expanso, 5–8 cm. lato, albo vel roseo-isabellino; lamellis adnatis, albis, sporis 10–12 × 4–6 μ; stipite albo, floccoso, volva et velo fragilibus.

Pileus convex to expanded, scattered, gregarious or cespitose, 5–8 cm. broad; surface dry, white or rosy-isabelline, decorated with small pointed warts and floccose scales, margin even, appendiculate; context thin, white, odorless; lamellae adnate, rather close, narrow, white, fimbriate; spores subcylindric, smooth, hyaline, about

10–12 × 4–6 μ; stipe slender, tapering upward, enlarged and radicate below, white, floccose, 5–10 × 1–1.5 cm.; volva and veil wholly friable.

Type collected by W. A. Murrill in mixed oak and pine woods at Gainesville, Fla., June 1, 1938 (No. *F 16449*). Also collected here by the author three other times under pine and once under oak (*F 16405, F 16462, F 16450, F 16482*). The spores are too elongate for *V. solitarius* and the gills too white for *V. praelongisporus*.

Venenarius virosiformis sp. nov.

Pileo convexo-plano, 6–8 cm. lato, glabro, albo, non striato; lamellis adnatis, sporis elongatis, 12 × 6 μ; stipite albo, bulboso, 8–9 × 1–1.5 cm., annulo amplo, volva magna.

Pileus convex to plane, solitary, 6–8 cm. broad; surface slightly viscid when wet, smooth, glabrous, white, margin even, entire; context thin, white, unchanging, with a distinct odor of chloride of lime; lamellae adnate, decurrent to the annulus in 1–3 raised lines, unequal, rather narrow, close or medium close, white, the edges fimbriate, finely serrate or much eroded; spores oblong-ellipsoid, smooth, white, with granular contents, about 12 × 6 μ; basidia very large and granular; cystidia none; stipe equal above the bulb or slightly tapering upward, smooth, glabrous, white, 8–9 × 1–1.5 cm.; bulb subglobose, white, not radicate, about 2.5 cm. wide and high; volva limb either spreading or collapsed, lobed or ragged, 1–1.5 cm. high; annulus 1–2 cm. from the apex, simple, membranous, ample, persistent, white.

Type collected by W. A. Murrill under a live-oak in Gainesville, Fla., May 26, 1938 (No. *F 16229*). Also collected by the author on a spaded lawn in Gainesville, May 25, 1938 (*F 16253*). Suggesting *Amanita virosa* Fries, but having elongate spores and the odor of chloride of lime. From *A. Gwyniana* Coker the spores and adnate gills distinguish it.

Venenarius fraternus sp. nov.

Pileo convexo-expanso, 2–4 cm. lato, viscido, melleo, disco subfuligineo; lamellis albis, sporis 6 × 4.5 μ; stipite roseo-isabellino, floccoso, 6–7 cm. longo, annulo albo, persistente.

Pileus convex to expanded, closely gregarious, 2–4 cm. broad; surface viscid, with few volval fragments, not striate, dull melleous with subfuliginous disk; context thin, white; lamellae free, broad,

crowded, white, the edges fimbriate; spores ovoid, smooth, hyaline, about $6 \times 4.5\ \mu$; stipe slender, equal above the small bulb, whitish-floccose, rosy-isabelline throughout, $6–7 \times 0.5–0.8$ cm.; volva fragile; annulus superior, about 2 cm. from the apex, white, membranous, persistent.

Type collected by W. A. Murrill under a laurel oak in Gainesville, Fla., June 7, 1938 (No. *F 16376*). Also collected by the author under an oak in Gainesville, June 8, 1938 (*F 16377*). Growing close together in small groups of three or four hymenophores. Much smaller than *V. flavorubescens* (Atk.) Murr., neither gibbous nor striate, and the stipe rosy-isabelline throughout.

Venenarius gemmatus volvatus var. nov.

Pileo glabro, striato; sporis $10–12 \times 6–8\ \mu$; volva lobata, 2 cm.; annulo magno, persistente.

Pileus convex to nearly plane, solitary, about 8 cm. broad; surface glabrous, without volval fragments, cremeous, dark isabelline on the disk, margin almost white, entire, distinctly striate for 1–2 cm.; lamellae adnexed, unequal, crowded, entire, white and drying white; spores ovoid, smooth, hyaline, granular, $10–12 \times 6–8\ \mu$; stipe tapering upward, smooth, white, floccose above and subglabrous below, about 12–16 cm. long and 6–10 mm. thick; bulb ovoid, white, 3 cm. high and 2.5 cm. thick; volva limb lobed, about 2 cm. high, flaring or collapsed; annulus large, membranous, white, persistent, fixed about 3 cm. from the apex.

Type collected by W. A. Murrill under a live-oak in Gainesville, Fla., May 28, 1938 (No. *F 16224*). Also collected by the author in oak-pine woods near Gainesville, May 29, 1938 (*F 16216*).

This is quite distinct from the northern plants I have seen in having a large volva similar to that of *A. verna* with no patches on the cap. This was true of at least twenty-five hymenophores picked during one afternoon in a woodland near Gainesville. Only one specimen of the typical form of *A. gemmata* had been found at that time but it appeared in abundance two weeks later under evergreen oaks, exhibiting all the variations so characteristic of the species.

Venenarius suballiaceus sp. nov.

Pileo convexo-expanso, 3–4 cm. lato, albo; lamellis liberis, sporis globosis, $6\ \mu$; stipite albo, $9 \times 0.5–1$ cm., annulo albo, persistente.

Pileus convex to expanded, scattered, 3–4 cm. broad; surface slightly viscid, smooth, white, glabrous, margin even, entire; context thin, white, unchanging, with a strong garlic odor; lamellae just free, without connecting ridges, close, entire, white, unchanging; spores globose or subglobose, smooth, hyaline, apiculate, granular, about 6 μ; stipe subequal above the deeply buried bulb, slender, subglabrous, smooth, white, 9×0.5–1 cm.; bulb ellipsoid, volva limb lobed; annulus white, membranous, thin, weak, attached at the very apex or near it and hanging like a wet skirt.

Type collected by W. A. Murrill in mixed woods of live-oak and loblolly pine at Gainesville, Fla., June 22, 1938 (No. *F 16495*). Suggesting *A. verna* but having smaller spores and a strong garlic odor, which persists for a time at least in the dried specimens. In *A. alliacea* the spores are elongate.

Lepiota subfulvastra sp. nov.

Pileo convexo, umbonato, caespitoso, 1–1.5 cm. lato, latericio-squamuloso; lamellis albis, sporis $6\text{–}7 \times 3\text{–}4\ \mu$; stipite bulboso, 1.5 cm. longo, annulo persistente.

Pileus convex, umbonate, cespitose or gregarious, 1–1.5 cm. broad; surface dry, pallid, squamulose, the scales and umbo latericious, margin entire, not at all striate; context membranous, pallid, unchanging; lamellae free, attached to a collar, ventricose, medium distant, unequal, entire, white, unchanging; spores ellipsoid, smooth, hyaline, $6\text{–}7 \times 3\text{–}4\ \mu$; stipe equal above the small bulb, subglabrous, smooth, pallid, or pale latericious, especially below, 1.5×0.1 cm.; annulus superior, membranous, white above, rosy-isabelline below.

Type collected by W. A. Murrill on an exposed bank in Gainesville, Fla., June 6, 1938 (*F 16446*). Very pretty with its small red umbo and reddish scales, usually growing in clusters of three or four hymenophores.

Lepiota subrhodopepla sp. nov.

Pileo expanso, 3–4 cm. lato, striato, squamuloso, albo, disco isabellino; lamellis liberis, albis, rubescentibus; sporis $5\text{–}6 \times 4\text{–}5\ \mu$; stipite glabro, albo, rubescente, 3–6 cm. longo; annulo albo, rubescente.

Pileus convex to expanded, not umbonate, solitary, 3–4 cm. broad; surface long-striate, dry, squamulose, white, isabelline on the disk, becoming pink about the margin on drying; context thin, white, pink when dry; lamellae free, narrow, crowded, white, pink

when dry, whitish-fimbriate on the edges; spores subglobose to broadly-ellipsoid, smooth, hyaline, uniguttulate, 5–6 × 4–5 μ; cystidia none; stipe long, slender, tapering upward from an abruptly bulbous base, smooth, glabrous, white, dark-pink when dry, 3–6 × 0.3–0.4 cm.; annulus median, membranous, persistent, loosely attached, white, changing to pink on drying.

Type collected by W. A. Murrill on a lawn in Gainesville, Fla., June 1, 1938 (No. *F 16235*). Also collected by the author on a lawn in Gainesville, June 3, 1938 (*F 16375*). Suggesting *Lepiota rhodopepla* Morgan but having narrow, crowded gills and shorter spores. The color of the dried gills is a beautiful dark-roseous shade.

Gymnopus subagricola sp. nov.

Pileo convexo, 1 cm. lato, isabellino, glabro; lamellis adnatis, pallidis; stipite glabro, 2–3 × 0.1–0.2 cm.

Pileus regularly convex, not fully expanding, gregarious, scarcely 1 cm. broad; surface dry, smooth, glabrous, isabelline or pale rosy-isabelline, margin even, entire, becoming hygrophanous and discolored; context thin, discolored under the cuticle, pallid below, with pleasant odor and mawkish flavor, becoming slightly astringent; lamellae adnate with decurrent tooth, subdistant, unequal, broad, entire, pallid to discolored; spores smooth, hyaline, scarce, 3–4 μ long; stipe enlarged and white at the apex, subequal and rosy-isabelline below, smooth, glabrous, 2–3 × 0.1–0.2 cm.

Type collected by W. A. Murrill on a road through oak woods in Gainesville, Fla., June 24, 1938 (No. *F 16323*). One of the inconspicuous things that most persons would overlook or ignore.

Gymnopus Tricholoma sp. nov.

Pileo convexo-depresso, 1 cm. lato, tomentosulo, albido, disco isabellino; lamellis sinuatis, subdistantibus, sporis ellipsoideis, 6–7 × 4–5 μ; stipite albo, cartilagineo, 1.5–2 × 0.2–0.3 cm.

Pileus convex to depressed, gregarious, 1 cm. or less broad; surface minutely tomentose, dry, smooth, pallid, isabelline on the disk, margin even, entire; context thin, white, odorless; lamellae sinuate, rather distant, broad, equal, entire, pallid; spores ellipsoid, inequilateral, smooth, hyaline, 6–7 × 4–5 μ; stipe tapering upward, compressed, smooth, finely fibrillose, white, cartilaginous, 1.5–2 × 0.2–0.3 cm.

Type collected by W. A. Murrill under a pine in Gainesville, Fla., June 7, 1938 (No. *F 16386*). Suggesting *Tricholoma* but having a cartilaginous stem.

Hydrocybe foliirubens sp. nov.

Pileo conico, 1–1.5 cm. lato, purpureo-rubro; lamellis ochroleucis, rubescentibus, sporis 8–10 × 4 µ; stipite rubro et flavo, 3–4 × 0.1–0.15 cm.

Pileus conic, gregarious, 1–1.5 cm. broad; surface dry, smooth, glabrous, purplish-ruber, more or less blackish-chestnut on drying, margin entire, even; context very thin, odorless; lamellae distant, equal, narrow behind, very broad at the tip, entire, ochroleucous, becoming miniatous on drying; spores elongate, obliquely apiculate, uniguttulate, smooth, hyaline, 8–10 × 4 µ; stipe very slender, equal, smooth, glabrous, red above, yellow below, slightly greenish at the very base, 3–4 × 0.1–0.15 cm.

Type collected by W. A. Murrill on a lawn under an oak in Gainesville, Fla., June 8, 1938 (No. *F 16432*). Resembling *H. conica* in shape but much smaller and the gills turn red instead of black. A beautiful, dainty species without any near relatives in this country.

Omphalina floridana sp. nov.

Pileo convexo-depresso, umbilicato, 8–13 mm. lato, albo, glabro; lamellis distantibus; sporis 5 × 3 µ; stipite albo, glabro, 1–1.2 × 0.1–0.2 cm.

Pileus convex to depressed, umbilicate, gregarious, 8–13 cm. broad; surface somewhat uneven, glabrous, white, margin even, entire, incurved when young; context very thin, white, unchanging, fleshy, decidedly farinaceous in odor and taste; lamellae strongly decurrent, white, narrow, inserted, distant, none forked, edges thin, entire; spores ellipsoid, smoth, hyaline, about 5 × 3 µ; stipe equal or subequal, cartilaginous, smooth, glabrous, white, 1–1.2 cm. long, 1–2 mm. thick.

Type collected by W. A. Murrill on open bare ground in Gainesville, Fla., May 31, 1938 (No. *F 16223*). Suggesting at first sight a tiny *Clitocybe dealbata*. Several score of the little white hymenophores were found after a heavy rain.

Lactaria arcuata sp. nov.

Pileo convexo-depresso, 6 cm. lato, albo, glabro; lamellis albis, arcuatis, lacte alba, piperata; sporis verruculosis, subglobosis, 4–6 µ longis; stipite albo, breve, 2.5 × 1.5 cm.

Pileus convex to depressed, solitary, 6 cm. broad; surface slightly viscid when moist, rough, glabrous, white, margin entire, even, thin, soft, involute; context and latex white, unchanging, moderately acrid at once, at length bitter; lamellae adnate or slightly decurrent, narrow, strongly arched, rather close, a few forked and a few inserted, white, unchanging, edges mostly entire; spores subglobose, verruculose, white, 4–6 μ long; stipe very short, subglabrous, white, unchanging, equal, 2.5 × 1.5 cm.

Type collected by W. A. Murrill under a laurel oak in Gainesville, Fla., June 15, 1938 (No. *F 16366*). White throughout, even when dried. Gills finely arched; spores much smaller than in most of our white species.

Russula subalbidula sp. nov.

Pileo convexo-depresso, 6–10 cm. lato, glabro, albo, disco cremeo, sapore piperato; sporis globosis vel subglobosis, cremeo-albis, 6–8 μ longis; stipite albo, glabro, 4 × 1.5–2 cm.

Pileus convex to plane or somewhat depressed, not umbonate, gregarious, 6–10 cm. broad; surface smooth, glabrous, slightly viscid when moist, white with cremeous center, entirely cremeous in age or on drying, pellicle not separable, margin entire, rarely striate; context firm, white, odorless, soon rather acrid; lamellae rather narrow, crowded, equal, adnexed, entire, milk-white, becoming dingy yellowish-white with age; spores globose or subglobose, closely and conspicuously echinulate, creamy-white, 6–8 μ long; stipe tapering upward or sometimes equal, short, smooth, glabrous, milk-white, 4 × 1.5–2 cm.

Type collected by W. A. Murrill on a lawn under laurel oaks in Gainesville, June 4, 1938 (No. *F 16403*). Abundant under evergreen oaks in Gainesville early in June, 1938, and collected several times by the author. Its color and acrid taste at first suggested *R. albidula,* which grows commonly under pines and cedars, but it differs in shape, spore characters, habitat, taste, the color of the disk, and the adnate pellicle. Sterile cells are abundant on the edges of the gills, projecting about 30 μ.

Russula subdensifolia sp. nov.

Pileo convexo-depresso, 7 cm. lato, glabro, cremeo, tuberculato-striato, subnigricante, sapore grato; sporis albis, spinulosis, 6–7 μ longis; stipite glabro, albo ad cinereo, 7 × 1.5–2 cm.

Pileus convex to depressed, solitary, 7 cm. broad; surface slightly viscid when wet, glabrous, cremeous, margin entire, widely tuberculate-striate; context thin, white, mild, odorless; lamellae adnate, rather close, of medium width, mostly equal, entire, pallid; spores subglobose, spinulose, hyaline, 6–7 μ long; cystidia none; stipe subequal, smooth, glabrous, milk-white, 7 × 1.5–2 cm. On drying the surface of the pileus becomes pale umbrinous, while the lamellae and stipe become cinereous.

Type collected by W. A. Murrill under a live-oak in Gainesville, Fla., June 1, 1938 (*F 16447*). This species has characters in common with *R. decolorans* and also with the group to which *R. densifolia* belongs. The spores are conspicuously spinulose. One is hardly prepared for the entire change in color on drying.

Russula subincarnata sp. nov.

Pileo convexo-depresso, 5 cm. lato, viscido, striato, incarnato, sapore grato; lamellis distantibus, sporis stramineis, globosis, echinulatis, 7–8 μ; stipite roseo, 3 × 1 cm.

Pileus convex to slightly depressed, solitary, 5 cm. broad; surface slightly viscid, glabrous, coarsely and conspicuously striate, peeling readily, uniformly dull incarnate, margin entire; context thin, sweet, white, rosy under the cuticle; lamellae adnate or slightly decurrent, equal, a few forked, broad, distant, entire, white to stramineous; spores stramineous in mass, globose, strongly echinulate, 7–8 μ; stipe subequal, smooth, glabrous, roseous, 3 × 1 cm.

Type collected by W. A. Murrill under a pine in Gainesville, Fla., June 8, 1938 (No. *F 16448*). A rare species of unusual appearance, with its red, striate cap, rosy stem, and distant gills.

Russula subflava sp. nov.

Pileo convexo-expanso, 6 cm. lato, glabro, viscido, ochroleuco, margine striato; sapore grato; sporis albis, globosis, 6 μ; stipite albo, glabro, 6–7 × 1–2 cm.

Pileus convex to slightly depressed, gregarious, about 5–6 cm. broad; surface smooth, glabrous, viscid when wet, peeling readily, uniformly ochroleucous; margin entire, striate for 5 mm. or more; context white, unchanging, mild, odorless; lamellae adnexed, rather close, narrow, half of them forked at the base, very few inserted, white with a pale-yellowish tint; spores white, globose, echinulate

about 6 μ; cystidia none; stipe smooth, glabrous, milk-white, stuffed, 6–7 × 1–2 cm.

Type collected by W. A. Murrill under a live-oak in Gainesville, Fla., May 30, 1938 (No. *F 16256*). Suggesting the somewhat mythical *R. flava* Romell but differing in several ways. A pretty plant when fresh, with its pale-yellow cap and pure-white stem, but the colors fade a little on drying.

Russula Westii sp. nov.

Pileo convexo-depresso, 3–4 cm. lato, glabro, albo, sapore grato; sporis cremeis, 7 × 5 μ; stipite albo, glabro, 2–2.5 × 1–1.5 cm.

Pileus convex to depressed at the center, gregarious, 3–4 cm. broad; surface slightly viscid, smooth, glabrous, uniformly white, pale yellowish when dry, cuticle adnate, margin entire, even; context firm, rather thick, sweet and nutty, odorless, white, unchanging; lamellae white, adnate, medium broad, close, entire, many forked at the base; spores cremeous in mass, broadly ellipsoid, minutely verrucose, uniguttulate, 7 × 5 μ; stipe short, equal or subequal, smooth, glabrous, white, unchanging, stuffed, about 2–2.5 × 1–1.5 cm.

Type collected by Erdman West under an oak in Gainesville, Fla., June 9, 1938 (No. *F 16404*). A small, neat species, white throughout but with cremeous spores. The flavor is sweet and nutty without any later unpleasantness. Mr. West examined the spores for me under high magnification. They are unusual for the genus.

Entoloma alachuanum sp. nov.

Pileo convexo-expanso, cespitoso, 2.5 cm. lato, umbrino, striato, sapore farinaceo; sporis valde angulatis, 7–8 μ, stipite glabro, pallidiore, 3–4 × 0.2–0.3 cm.

Pileus convex to expanded, papillate, cespitose, about 2.5 cm. broad, surface glabrous, umbrinous with fuliginous umbo, margin entire, striate; context thin, white or pallid, odorless but with strongly farinaceous taste; lamellae sinuate or adnate with decurrent tooth, unequal, rather distant, of medium width, entire, pallid to dark-pink; spores decidedly angular, apiculate, usually 1–2 guttulate, pink, 7–8 μ in diameter; stipe fleshy, equal, smooth, glabrous, shining, pale avellaneous or pale fumose, 3–4 × 0.2–0.3 cm.

Type collected by W. A. Murrill in an open pasture south of Gainesville, Fla., June 3, 1938 (No. *F 16509*). A small, dark, clustered species with a decidedly farinaceous flavor. The spores are beautifully polygonal, about as broad as long, with a prominent apiculus.

Entoloma pernivosum sp. nov.

Pileo convexo-expanso, albo, subglabro, non striato, 1.5–2 cm. lato; sporis angulatis, pallidis, 8 × 5 μ; cystidiis 35–45 × 10–15 μ, fusoideo-ventricosis apice lobatis; stipite glabro, albo, subbulboso, 3 × 0.3–0.5 cm.

Hymenophore snow-white throughout; pileus convex to expanded, not umbonate, gregarious, about 1.5–2 cm. broad; surface uneven, not striate, very slightly innate-fibrillose, margin entire; context thin, without odor or taste; lamellae adnate or adnexed, unequal, rather narrow, medium close, entire; spores ellipsoid in outline, angular, uniguttulate, very pale, about 8 × 5 μ; cystidia flask-shaped, capitate, with lobed apex, abundant, about 35–45 × 10–15 μ; stipe smooth, glabrous, equal above the slightly enlarged base, about 3 × 0.3–0.5 cm.

Type collected by W. A. Murrill on a lawn in Gainesville, Fla., May 26, 1938 (*F 16220*). A white species without close relatives. The cystidia suggest ovaries with sessile, lobed stigmas.

Pluteus citrinus sp. nov.

Pileo convexo, umbonato, squamuloso, citrino, 5 cm. lato; sporis subglobosis, 5–6 μ, cystidiis 30 × 12 μ; stipite glabro, cremeo, 4 × 0.5–0.8 cm.

Pileus convex to subexpanded, solitary, 5 cm. broad; surface dry, slightly innate-fibrillose, citrinous, finely squamulose and isabelline-flavous on the low, broad umbo; margin even, entire, concolorous; context firm, white, unchanging, taste nutty; lamellae free, rounded behind, rather broad, medium close, 2–3 times inserted, entire, soon rose-colored; spores broadly ellipsoid or subglobose, smooth, pink, 5–6 μ long; cystidia tapering from a swollen base, hyaline, pointed, abundant, about 30 × 12 μ; stipe enlarged above and below, glabrous, slightly striate, solid, cremeous, 4 × 0.5–0.8 cm.

Type collected by W. A. Murrill on an oak log at Magnesia Springs, Alachua Co., Fla., May 22, 1938 (No. *F 16251*). A strikingly beautiful species related to *P. leoninus* (Schaeff.) Quél. but with smaller spores and the margin not at all striate.

Galerula caespitosa sp. nov.

Pileo semiglobato, caespitoso, 1.5 cm. lato, micaceo, striato; sporis ellipsoideis, 11–13 × 6–7 μ; stipite albo, glabro, 2–4 × 0.1–0.3 cm.

Pileus hemispheric, not fully expanding, strictly cespitose, 1.5 cm. broad; surface dry, pulverulent, glistening like mica, long-striate, uniformly pale rosy-isabelline or avellaneous, margin entire; context very thin, pallid; lamellae squarely adnate, narrow, crowded, unequal, pallid to fulvous, whitish on the edges; spores ellipsoid, smooth, yellowish-brown, 11–13 × 6–7 μ; stipe slender, equal, smooth, glabrous, white, 2–4 × 0.1–0.3 cm.

Type collected by W. A. Murrill under an oak in Gainesville, Fla., May 29, 1938 (No. *F 16389*). Also collected by the author on a chip in a sawdust pile in Gainesville, June 1, 1938 (*F 16437*). Near *G. Kellermani* (Peck) Murr. but definitely cespitose and having longer spores.

Galerula floridana sp. nov.

Pileo conico-subexpanso, 2–5 cm. broad, isabellino, glabro; sporis ovoideis vel ellipsoideis, 8–9 × 6–7 μ; stipite longo, radicato, pallido, 7–10 × 0.1–0.3 cm.

Pileus conic to subexpanded, solitary, 2–5 cm. broad; surface dry, smooth, glabrous, uniformly isabelline, margin entire, even, upturned with age; context thin, pallid, odorless; lamellae adnate or adnexed, narrow, close, unequal, entire, soon becoming pale fulvous; spores ovoid or ellipsoid, truncate, smooth, yellowish-brown, uniguttulate, 8–9 × 6–7 μ; stipe long, slender, equal, smooth, glabrous, long-radicate, pallid, 7–10 × 0.1–0.3 cm.

Type collected by W. A. Murrill in sandy soil under trees in Sugarfoot Hammock, near Gainesville, Fla., June 5, 1938 (No. *F 16435*). Also collected by the author in oak woods at Gainesville, June 3, 1938 (*F 16387*). This species has the typical *Galera* form when young but in age assumes the shape of a hat with high crown and upturned brim. The stem is long-radicate as in *Collybia radicata.*

Drosophila floridana sp. nov.

Pileo convexo-subexpanso, fulvo, tomentosulo, 1–1.5 cm. lato, margine appendiculato; lamellis adnatis; sporis 7 × 5 μ; stipite 2 × 0.2–0.4 cm.

Pileus hemispheric to broadly convex, not fully expanding, not umbonate, gregarious, 1–1.5 cm. broad; surface hygrophanous, not viscid, smooth, tomentulose, uniformly fulvous; margin conspicuously appendiculate with a white fringe; context thick, white, unchanging, sweet, nutty; hymenium plane, pallid, soon becoming purplish; lamellae broadly adnate with a slight notch, several times inserted, medium close, quite broad, the edges densely fringed with long, pointed, hyaline, sterile cells; spores ellipsoid, smooth, dark purplish-brown, about $7 \times 5\ \mu$; stipe equal or subequal, smooth, glabrous and white above, floccose and yellowish below, fistulose, pallid within, about 2×0.2–0.4 cm.

Type collected by W. A. Murrill on open bare ground in Gainesville, Fla., May 31, 1938 (No. *F 16227*). A small, shapely species with a conspicuous white fringe on the margin of a fulvous cap. In very young stages the white veil is continuous but it soon breaks up into small fragments. In older stages the marginal zone may become ochraceous while the disk remains fulvous.

Stropharia bilamellata tomentosa var. nov.

Pileo isabellino, tomentoso; sporis 6–8×4–$5\ \mu$.

Pileus convex to hemispheric, solitary, 4 cm. broad; surface smooth, dark isabelline, densely tomentose; context thick, isabelline, mild; lamellae sinuate; spores ovoid or ellipsoid, 6–8×4–$5\ \mu$; stipe stout, 1.3 cm. thick.

Type collected by W. A. Murrill under an oak in Gainesville, Fla., May 28, 1938 (No. *F 16230*). Very different from the typical smooth, white or pale-yellowish form so common on southern lawns.

Agaricus pocillator sp. nov.

Pileo convexo-expanso, 7–10 cm. lato, albo, squamuloso, disco umbrino; sporis ovoideis, 4–$5 \times 3\ \mu$; stipite albo, 6–8×0.6–0.8 cm.

Pileus truncate-convex to plane, gregarious or subcespitose, 7–10 cm. broad; surface dry, smooth, white, decorated with minute, dark, floccose scales, fuscous on the disk; context thin, white, unchanging, sweet, edible; lamellae close, rather narrow, white, turning pink and finally blackish-brown; spores ellipsoid, smooth, purplish-brown, about 4–$5 \times 3\ \mu$; stipe slender, 6–8×0.6–0.8 cm., smooth, subglabrous, white, enlarged at the base, usually in the

form of a shallow cup about 1.5 cm. broad and 4 mm. high; annulus apical, membranous, ample, persistent, simple, white.

Type collected by W. A. Murrill under a laurel oak in Gainesville, Fla., June 4, 1938 (No. *F 16476*). Also collected by various persons under hardwoods in and about Gainesville (*F 16428, F 16352, F 16344, F 16277, F 16477, F 16429, F 16353*). This is a shade-loving species, attractive in appearance and excellent for the table. The cup at the base of the stem is quite remarkable and unexpected. In drying, the cup usually becomes finely rimose-striate from the splitting of the cuticle and the disk turns almost black.

Agaricus projectellus sp. nov.

Pileo convexo-plano, 6–8 cm. lato, glabro vel squamuloso; lamellis pallidis, sporis ellipsoideis, 5.5–6 × 3.5–4 μ; stipite 5–8 cm. longo.

Pileus convex to plane, gibbous at times, scattered or gregarious, 6–8 cm. broad; surface dry, smooth, white, sometimes cremeous on the disk, glabrous or with minute, erect, floccose scales; margin projecting 5 mm. at times; context white, unchanging, sweet, edible; lamellae narrow, crowded, pallid for some time before turning pink, finally purplish-brown; spores ellipsoid, smooth, purplish-brown, uniguttulate, 5.5–6 × 3.5–4 μ; stipe smooth, white, subglabrous, subequal, 5–8 × 0.8–1.5 cm.; annulus white, median, ample.

Type collected by E. West, L. Arnold and W. A. Murrill in a pasture south of Gainesville, Fla., June 3, 1938 (No. *F 16219*). Also collected here several times by the author (*F 16431, F 16507, F 16355, F 16299, F 16430, F 16506*) on lawns and in pastures, where it is mistaken by mycophagists for *Agaricus campester*. The young gills, however, are whiter; the margin more projecting; and the spores considerably shorter than in the common meadow mushroom.

Agaricus subplacomyces badius var. nov.

Pileo convexo-expanso, 6–12 cm. lato, albo, badio-squamuloso; sporis 5–6 × 3–3.5 μ; stipite albo, bulboso, 5–10 × 0.8–2 cm.; annulo albo, amplo, persistente.

Pileus convex to expanded, not umbonate, gregarious, 6–12 cm. broad; surface dry, white, conspicuously squamulose, the scales

and disk bay; margin entire, even; context rather thick, white, unchanging, fragrant, nutty; lamellae free but not remote, rounded behind, medium broad, rather close, entire, white when young; spores ellipsoid, smooth, uniguttulate, purplish-brown, 5–6 × 3–3.5 μ; stipe tapering upward from an ovoid bulb, glabrous above the annulus, floccose below, smooth, white, stuffed to hollow, 5–10 × 0.8–2 cm.; annulus superior, membranous, white, persistent.

Type collected by W. A. Murrill under a live-oak in Gainesville, Fla., June 7, 1938 (*F 16402*). A common species here and collected several times about Gainesville in quantity for food, being of excellent flavor even in the raw state. It differs from *A. placomyces* in its shorter, thicker stem, bay disk and scales, and fragrant odor.

NEW COMBINATIONS

For those using Saccardo's nomenclature the following new combinations are made:

DROSOPHILA FLORIDANA = **Hypholoma floridanum**
GALERULA CAESPITOSA = **Galera caespitosa**
GALERULA FLORIDANA = **Galera floridana**
GYMNOPUS SUBAGRICOLA = **Collybia subagricola**
GYMNOPUS TRICHOLOMA = **Collybia Tricholoma**
HYDROCYBE FOLIIRUBENS = **Hygrophorus foliirubens**
OMPHALINA FLORIDANA = **Omphalia floridana**
VENENARIUS ALLIACEUS = **Amanita alliacea**
VENENARIUS FRATERNUS = **Amanita fraterna**
VENENARIUS PRAELONGISPORUS = **Amanita praelongispora**
VENENARIUS SOLITARIIFORMIS = **Amanita solitariiformis**
VENENARIUS SUBALLIACEUS = **Amanita suballiacea**
VENENARIUS SUBSOLITARIUS = **Amanita subsolitaria**
VENENARIUS VIROSIFORMIS = **Amanita virosiformis**

FLORIDA AGRICULTURAL EXPERIMENT STATION,
GAINESVILLE, FLA.

NOTES AND BRIEF ARTICLES

Water Moulds as a Source of Infection by Pathogenic Species of Phytophthora

In a paper entitled: "The Invalidity of Pythiomorpha" (Trans. Brit. Myc. Soc. vol. XXV, where the argument can be read in full), the authors demonstrate beyond doubt that the reported occurrences of *Pythiomorpha spp.* are in reality records of species of *Phytophthora* (or, rarely, of *Pythium*) found growing saprophytically in water. Until recently *Phytophthora* has not been known as a genus including water moulds, the reason no doubt being that when grown in water, species of *Phytophthora* tend to produce the proliferating sporangium, a feature claimed as the diagnostic characteristic of "*Pythiomorpha.*" It now appears that just as parasitic species of *Phytophthora* can lead a saprophytic existence in the soil, so they may abide saprophytically in water.

The authors are now collecting strains of "*Pythiomorpha*" from all available sources and endeavouring to isolate and identify them, expecting them, for the most part, to be readily assigned to known species of *Phytophthora*. They would recommend that collectors of water moulds all over the world should proceed with caution in the naming of water moulds with a "*Pythiomorpha*" habit, and report any disease-causing species of *Phytophthora* they may isolate from water. They would be interested to hear of any such isolations.—E. M. Blackwell and G. M. Waterhouse

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Is Shiitake a Cortinellus?

The taxonomic position of one of the most important edible fungi of the world, the East Asiatic Shiitake (jap. shii, pronounce: she-e = Pasania; take = mushroom) was quite obscure when I had the opportunity of observing fresh material on my travel through Japan.

Some authors did not even distinguish the Shiitake from the Matsu-take (jap. matsu = pine; take = mushroom), the Matsu-

take being a species of *Tricholoma,* a form of the *T. caligatum*—group, and, as I believe now, perhaps identical with it.

The real Shiitake were sold in January and February on the markets of Kobe, Osaka, Kyoto and Tokyo in fresh and also in dried conditions. It is in cultivation in Japan and gives fruit bodies in all seasons. It has nothing in common with a *Tricholoma.* I bought some characteristic specimens and dried them after macroscopical analysis. The dried material reminded me of some dried exsiccata of *Cortinellus Shiitake,* I had examined in European herbaria. Some years ago I stated that Shiitake from our collections belongs to the genus *Lentinus* but I was afraid that there might have been some mistake in the determination of the specimens examined by me. The anatomic analyses I made in The New York Botanical Garden confirmed my opinion that the *Cortinellus* of the European collections and the Shiitake from the Japanese markets are one and the same species.

Why cannot this species be a *Cortinellus?* The answer is:

Cortinellus in the original idea of Roze chiefly corresponds to a group of veiled *Tricholoma.* In the modern conception, adopted in my system of the Agaricales,[1] *Cortinellus* is restricted to *Cortinellus bulbiger,* an isolated species which, according to my special studies, has not only a *Cortinarius*-like appearance and spore form but also yellowish spore powder and thick spore walls. Shiitake has non bulbus (in general nothing like a *Cortinarius*) ellipsoid-cylindrical spores with very thin membranes. The color of the spores is pure white.

Therefore, there is no doubt that Shiitake is not a *Cortinellus* in the sense of *Cortinellus bulbiger.* But, perhaps, it is a "*Cortinellus*" of the *Tricholoma vaccinum*-type?

Tricholoma vaccinum and allied species have short spores, no thick walled hyphae, no clamp-connections, and they never grow on wood. Shiitake grows on wood of deciduous trees. Its hyphae are principally thick-walled and always have clamp-connections; its spores are almost cylindrical. Also the character of the surface hyphae of the pileus is quite different.[2]

[1] Singer, R. Das System der Agaricales. Ann. Myc. **34**: 286. 1936.

[2] I have to express my gratitude to Dr. Seaver, who was kind enough to allow me the privilege of studying my Japanese material in the herbarium

The only genus with which Shiitake shows an evident affinity is *Lentinus*. The following description, made from our Japanese specimens cannot fail to convince one that all diagnostic characters of this mushroom indicate *Lentinus:*

Lentinus edodes (Berk. non Schröt.) Singer, comb. nov.

Pileus light-brown or dark-brown with a somewhat reddish-brown tinge, scales and center dark, more pale-brown in young specimens at the margin; dry, with innate, triangular or areolate, small or large scales, often fissured in areas or with large white longitudinal fissures, with a colorless to pale-brownish cortina on and near the very acute margin of young fruit bodies, then glabrous and only sometimes with a narrow tomentose marginal zone, convex, later depressed around the convex center, sometimes plane or slightly depressed at last, often really umbonate, 50–110 mm (4–20 cm sec, Imai).—No true epicutis; hyphae of the scales filamentous, interwoven.

Lamellae pale-whitish, later often with reddish-brown spots, especially, where handled, finally with an extremely faint grayish incarnate or brownish tinge; adnate or adnexed-sinuate, but generally soon separating from the stipe and seeming free, crowded or very crowded, up to 4 mm broad the largest point being near the stipe, wavy-denticulate, not ventricose or ventricose near the stipe. —Spore powder pure white.—Spores cylindric-ellipsoid, thin walled, $5.8–6.4 \times 2.8–3.3\ \mu$, non amyloid, smooth. Basidia with 4 sterigmas, $30–31.5 \times 5.8\ \mu$. Trama regular. Hyphae of the trama hyaline, not amyloid, $5–6\ \mu$ in diameter, many of them thick-walled (until $1.6\ \mu$).

Stipe light reddish-brown, whitish-brown, with a ring like cortina downward with darker-brown scales, mostly smooth from the cortina up, often with rib like continuation of the lamellae, solid, hard and subcoriaceous, the thickest part generally in the middle, rarely bulbous at the base, more often compressed, but sometimes central and round (the form of the stipe depends from the position of the substratum, as Sh. Imai states), $30–40 \times 8–13$ mm, rarely larger.

Context white, brownish under the surface of the pileus, fleshy to tough. Taste slightly acid, not unpleasant. Smell very slight. Hyphae with clamp-connections and many of them thickwalled.

Said to occur only on deciduous trees (Pasania, beech and others). January–December. Eastern Asia.—Rolf Singer.

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of the New York Botanical Garden. The original exsiccata are deposited in the same Herbarium.

D. H. Linder, President 1940

MYCOLOGIA

OFFICIAL ORGAN OF THE MYCOLOGICAL SOCIETY OF AMERICA

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MYCOLOGISTS IN RELATION TO OTHERS [1]

DAVID H. LINDER

As you are well aware, we are living in a very uncertain period, one in which many peoples have lost not only their political, but also their scientific freedom, while others have had their privileges curtailed or postponed. It is for us, who still have freedom of action, a solemn duty not only to consider what we are able to do to maintain our liberty as mycologists, but also what we can do to serve our country by helping in building or in aiding our defenses and still continue to add to the knowledge of our subject that has been built up through the efforts of past generations.

For the good of our souls, we might as well admit that taxonomic mycology started out in much the same spirit as the boy stamp collector, but the growth of knowledge of the fungi and the resulting broadened view has led to the recognition of the value of the subject for scientific study and contacts have been made with many fields, among which are cytology, genetics, medicine, chemistry, and agriculture. In view of these broad contacts of mycology with other branches of scientific endeavor, the Mycological Society with the diverse interests represented in its membership, should be in a position to aid in national defense and welfare. Today, therefore, it seems desirable to point out a few ways in which we can assist the national cause, and at the same time to suggest to the Society that its members be formulating additional ideas as to how we may be of greater service.

[1] Address of the retiring president, presented before the Mycological Society of America at Philadelphia.

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In spite of crop restriction and our present so-called surplus of certain farm products, I have a feeling that we are going to be happy over the fact that we have them, if not for our own country, at least for peoples of other countries who have had the misfortune to have been prevented from sowing crops. Just as we may be glad to have a reserve of farm crops, I feel equally sure that we shall also have need of all possible reserve knowledge of plant diseases and the fungi that cause them, in order to meet unexpected conditions that may develop as the seasons vary from year to year. For that reason, nothing should be done that will hinder the increasing of our knowledge of plant and forest pathology. While this is a pat on the back for phytopathologists, it should be added that it is not for the "spray gun artists" as the late Dr. Thaxter so aptly described some members of the profession, but for those individuals who have a sound training in taxonomic mycology—the people who know how to classify the organisms with which they are working, who know the morphology and life-histories and who can, as a result, work out effective and efficient control measures. While a well trained mycologist can do fully as well as a phytopathologist, coöperation between the two groups is the end to be desired. There is absolutely no need for either set of disciples to feel that one has the corner on knowledge to the exclusion of the other.

Medicine is another field in which the mycologists may be of great service. They can assist in building up a reserve of technical ability in time of war. The culture methods of the mycologists are not so unlike those of the bacteriologists that we who are older or physically decrepit cannot at least train young men and women in the techniques of isolation, culturing, and staining of bacteria. People so trained under the mycologists, but with the helpful suggestions of the doctors, would in certain ways have an advantage over those trained only in bacteriological methods for they would be meeting the problem with an entirely new point of view and at the same time would be interested in the possible presence of fungi in infections. In a national emergency, then, there is no reason why, by adjusting our courses to suit the needs, we cannot help train laboratory technicians who can be of great assistance to the more highly trained products of the medical schools and thus free

more doctors for the care of the sick and wounded among the fighting forces or the civilian population.

Whether in war or in peace, medical mycology has a very definite place in the scheme of things, a fact that I believe is more definitely recognized today than in past years. Those of us who have been interested in medical mycology have seen that under the wings of the doctors, the study of fungi that cause diseases has become more and more confusing. This, in part, has been the result of insufficient knowledge of the fungi themselves, and in part because of placing too great emphasis on giving high sounding names to different symptoms that may be produced by a single fungus, or else a result of relying too greatly on gross morphological characters of the fungi as they appear on one or two culture media. Let us admit that in spite of the faults of the past procedures, they at least have furnished us with a starting point and a target at which to shoot. That the shooting has been pretty good has already been demonstrated by the fact that it has been proven that a single species of fungus may produce many of the different symptoms that have gone under sonorous, and to the layman, bewildering medical names. Also, it has been brought to light that a single species may break up into many races, so many that even the mycologists are bewildered although they now begin to show signs of recovery and are beginning to bring some order out of the chaos. Even with the fungi that cause skin blemishes and which have been studied more than any other forms, there still remains much to be done that is strictly within the realm of mycology. The first point that needs attention is the straightening out of the taxonomy of the species concerned. In view of the long list of species that have been described, and also of the lengthy synonymy of a few of the species that have been studied in recent years, it is evident that there remains much to be done and that there is room for more investigators. These investigators should have taxonomic training and should have some knowledge of the nutritional requirements of the fungi. It is my firm conviction that the almost universal use of Sabouraud's agar has done more to confuse taxonomy than any single factor. Peptone or peptone and sugar in agar, as used in the past, are not only unbalanced and do not furnish all the elements necessary for normal growth of the

fungi, but when these substances are supplied, they are in too great concentration. Test-tubes do not furnish a normal habitat, but when to this is added unfavorable nutritional factors, there is little wonder that the organisms go wild and produce all sorts of mutations. However, taxonomic training and cultural technique are not all that are necessary. A good general mycological background, including morphology and cytology, obtained from the study of a wide range of fungus groups as they appear in nature and not in books, is necessary in order to avoid the mistake of placing a single species in two or three orders, in more families, and in ten or more genera. Indeed, with our present knowledge of these forms, the hasty creation of new families and orders is to be condemned since, as has already happened, related species become so far separated by premature and improper arrangement that bringing them together may be a matter of chance. However, an attempt should always be made to determine generic affinities and to point them out so that eventually the fungi may be arranged according to a natural rather than to an admittedly temporary and artificial system of classification. In spite of the mistakes of the past, medical mycology has a very bright future, a future that will be all the brighter when there is close coöperation between the mycologists and the doctors. At present there is nothing to stand in the way of full coöperation except the M.D.'s prejudice against the Ph.D. and perhaps their feeling of omniscience. What is needed is a partnership between the two in which each will perform his special duties while working for the common cause of increased knowledge and the betterment of human welfare.

There are other fields to which mycologists may contribute their bit, but only a few points need be suggested where coöperation may be of assistance, although undoubtedly each member may have many other ideas. In the textile industry we can help, not only by assisting in improving methods of protecting cloth from the various fungi that cause mildew, but also in devising methods of retting fibers that may make available neglected plants which could furnish substitutes for products that may be cut off by embargoes in a foreign country. In the field of chemistry there is much to be learned about the possibilities of producing organic compounds

or about species that are capable of producing higher yields of a specified enzyme. Finally, in agriculture, with the coöperation of the chemists, it may be possible to find methods for the further utilization of the by-products of the farms. The new Federal Regional Laboratories have made a start in this direction but there is no reason under the sun why an individual who is qualified should sit back and wait for the government to do all the work. After all, the greatness and the high standards of living in this country have not resulted from people sitting back and waiting for the government to tell them what to do. They have gone ahead and done the work on their own initiative.

So far only the relations of mycology to other fields of endeavor have been briefly discussed. It now seems fitting that we should look at ourselves somewhat critically in an endeavor to see if we cannot profit by some of our mistakes and improve our opportunities. This portion of the paper is directed chiefly to taxonomists for it seems that if they are to furnish the names of the tools with which others work, they must strive for stability in nomenclature and must be able to make known the results of their efforts. The first plea to be made is that our members be more conscientious about conforming to the International Rules of Botanical Nomenclature. American taxonomists have at last been able to convince most of the world but the die-hards, that the type concept is an invaluable aid in securing stability in nomenclature and naturally we are enthusiastic about its universal application. If we want that concept to hold, we must be willing to be equally conscientious about applying the regulations that we like less well. While infractions of three or four rules may be cited, I refer specifically to the matter of Latin diagnoses. This requirement has been cussed and discussed in several of our meetings and in spite of the cogent reasons given for the maintenance of that rule, descriptions of new species still appear either without or with only sufficient Latin diagnosis to cover the minimum requirements that will enable the author's name to be perpetuated. Either treatment indicates an insular point of view on the author's part—certainly not the broader outlook that represents the ideals that we should have for scientific work. The danger of continuing to violate the code that is meant to serve not only Americans, but also Chinese,

Russian, and French as well, can well be illustrated by the conditions in Europe and Asia today. A parallel situation existed. Two or three leaders of cliques not liking the rules and regulations that governed international standards and relations, took matters into their own hands and broke one by one the rules to which the civilized world subscribed. Today the result is chaos and wanton waste of effort that promises to lead nowhere. If we American taxonomists don't want to live up to the rules to which we have subscribed, we are going to find that others will be equally loath to live up to those that they don't like, and the results botanically will be the same as the results politically. It is therefore up to each of us to live up to the rules made by the majority, but there is absolutely no reason why the minority should not endeavor to convince members of the International Congress that their procedures are greatly superior to the old, and endeavor to substitute a more workable and acceptable regulation or set of regulations. Clarification and simplification of the rules are needed, but until the desired changes are brought about in accordance with established methods, taxonomists are urged to live up to the present rules and not to take matters into their own hands.

We cannot complain about the International Rules if we do not do our part. One of the places where we have in the past fallen down on the job is in regard to the selection of generic names for conservation. The English in spite of the worries that they have undergone, have submitted a creditable list and in doing so they have given us a definite challenge to carry on their work. Not only is it a challenge, but it is also an opportunity for American mycologists to carry on the work and apply the type concept as it is accepted by the International Code. The task should be undertaken with a scientific point of view and with the paramount idea of obtaining stability in nomenclature. The application of the principle of usage should be kept to a minimum since a name that appears to be acceptable in the United States may neither be correct, nor acceptable in other countries.

There is also room for continued and even increased monographic studies since it is only by the comparison of a large amount of material of one genus or several related genera, by the thorough inspection of the literature, and through the experience thus re-

ceived, that truly fundamental taxonomic work in the field of taxonomic mycology may result, and the many tangles and uncertainties clarified. Furthermore, such monographic studies should not be confined to one region or one country since many species are widespread and the possibility exists that an organism that appears new to science because it has not previously been found on this continent may nevertheless have been found and described under one or two or even more names elsewhere. Unfortunately, the monographic studies while of immense value, nevertheless are a distinct handicap to the author since the matter of publication of longer papers is one that poses a problem that seems almost insuperable. The regular botanical journals are crowded, even with restrictions as to the length of an article, because of the great diversity of subjects submitted. The few periodicals that are able to accept more lengthy monographic treatments are not able to care for the many papers that might be submitted. In a word, there is quite definitely room for a taxonomic journal for cryptogamic botany, as well as for phanerogamic botany, and this journal need not in any way compete with our own MYCOLOGIA that must take care of the various needs and interests of approximately three hundred and fifty members. Because of the financial status of most scientific institutions, it seems justifiable to point out just one example of how, through unified action among libraries and with the coöperation of the scientific workers, money could be saved that would more than support two or three taxonomic journals. Our libraries have recently paid $45.00 for five parts, *not five volumes,* of *Botanisches Archiv,* which contains many lengthy and heavily padded papers such as would be expected when authors are paid by the page. Theoretically, all libraries should have a complete file of as many magazines as possible, but today with bibliofilm service available, that is not necessary. Accordingly, if all libraries would boycott journals of the kind just mentioned, the prices would drop to proper levels. Meantime, through the agency of one or two conveniently located libraries that are equipped for microfilm service, articles necessary for the prosecution of research could be obtained without undue delay or hardship. The current papers are surveyed in the Department of Agriculture's *Plant Science Literature* so that it should not be impossible to know what

is going on in any special field of botany and to obtain copies of the needed papers. By utilizing the advantages thus furnished, the resultant economies would more than offset the bibliofilm service and still leave sufficient funds for the support of one or two taxonomic periodicals costing $7.00 to $10.00 a year. If cutting out the one journal alone will allow these savings, even greater economy will result when more journals of a like nature are dropped, and then American money can be turned to the support of American science. It seems that if American students, who are now forced to pay for extra pages and plates and reprints, are willing for the love of the game to write articles without any more compensation than they receive from seeing in print a piece of work that has been well done, they should deserve first consideration and support.

FARLOW HERBARIUM,
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NEW AND UNUSUAL SPECIES OF DISCOMYCETES[1]

Bessie B. Kanouse

Botanical expeditions to various parts of North and Central America have provided collections of Discomycetes, some of which are of more than usual interest. Of the fungi collected, several are believed to be new species, and they are described in this paper. They belong in the following genera: *Belonopsis, Cenangium, Ciboria, Coronellaria, Dasyscyphella, Helotium, Tryblidaria* and *Unguicularia*. One variety of *Helotium* is raised to specific rank, and a new combination is made.

The collections are deposited in the Herbarium of the University of Michigan. The color names inclosed in parentheses are from R. Ridgway's Color Standards and Nomenclature.

Belonopsis montanensis sp. nov.

Apothecia superficialia, 1.5–4.5 mm. lata, primo globosa dein applanata, margine crenulato, sessilia, exciputo griseo-brunneo, hypothecio pseudoparenchymatico, hymenio aurantio; asci cylindraceo-clacati, longe pedicellati, 8 sporis, 130–155 × 9–12 μ; sporae hyalinae, aciculares, rectae vel saepe curvatae, 38–50 × 1.5–2 μ, 3 vel plus septate; paraphyses apice curvatae, tenue epithecium formantes.

In foliis emortius fagi et abietis.

Apothecia superficial, 1.5–4.5 mm. in diameter, at first globoid, the hymenium enclosed by the excipular layer, at maturity applanate to convex, the margin irregular with triangular patches of the remains of the excipular layer, broadly sessile, soft waxy, solitary, exciple pseudoparenchymatic, gray brown, hypothecium thick pseudoparenchymatic, hymenium "Mikado orange," to "deep chrome" when dry, slightly paler when moist; asci-cylindric-clavate, long-stemmed, apices accuminate, 8-spored, 130–155 × 9–12 μ J +; spores hyaline, acicular, straight or slightly curved, 38–50 × 1.5–2 μ, 4 (apparently sometimes 8 or more) celled, parallel in the upper part of the asci; paraphyses numerous,

[1] Papers from the Herbarium of the University of Michigan.

hyaline, filiform, twisted into coils or spirals at the apices, sometimes branched, colorless, forming a thin epithecium.

On fallen leaves of beech and on fir needles, Echo Lake, Flathead National Forest, Montana, July 19, 1928, G. B. Cummins.

This fungus is a typical species of *Belonopsis*. The margin is made conspicuous by the remnants of the covering layer that remain. In this feature the species resembles *Stamnaria equiseti* (Hoff.) Rehm and *Melachroia xanthomela* (Pers.) Boud. The twisted paraphyses are a second outstanding character. Although it is a small fungus it is conspicuous both in its macroscopical and microscopical characters.

Cenangium tennesseense sp. nov.

Apothecia erumpentia, sparsa vel caespitosa 2–4 in catervae, carnoso-cariacea, brevi stipitata, 2–3 mm. lata, 2–2.5 mm. alta, badia, umbrina exsiccata, hymenio nigro-brunneo, subtiliter furfuracea; asci 100–120 × 10 μ; sporae late fuscideae, hyalinae vel subhyalinae, non septatae, 11–14 × 6–8 μ; paraphyses filiformes, apice brunneae granulosae.

In ramulis emortuis.

Apothecia erumpent singly or in groups of 2–4, fleshy-leathery, short stipitate, 2–3 mm. in diameter, 2–2.5 mm. in height, "maroon" when moist, drying "bay," becoming enrolled, exciple pseudoprosenchymatic, fibrillose striate and minutely furfuraceous from the outermost layer of cells which are long, loosely interwoven, minutely rough, and light brown in color, hypothecium pseudoprosenchymatic, hyaline, hymenium becoming black-brown when dry; asci cylindric, thick-walled, 8-spored, 100–120 × 10 μ, J +; spores ovoid-fusoid, to broadly fusoid, containing one large central guttula and a small one at each end, irregularly uniseriate, hyaline to subhyaline, 1-celled, 11–14 × 6–8 μ; paraphyses filiform, narrowly clavate upwards, 3–4 μ in diameter, partially filled with brown coloring matter.

On dead twigs of deciduous wood (hazel or blue beech), Elkmont, Tennessee, June 11, 1939. L. R. Hesler *12139*. Part of type is deposited in the Univ. of Tennessee.

The delicate outermost layer of the exciple is easily rubbed off exposing a smooth red-brown layer underneath. Only with careful handling of the specimens will this character be observed.

Ciboria rufescens sp. nov.

Apothecia breviter stipitata, 2–3 mm. lata, stipibus 1–2 mm. altis, flavido-aurantiacea, sanguinea, exsiccata; asci 35–60 × 7–8 μ, 8 sporis; sporae 7–8 × 3.5 μ, nonseptatae, hyalinae, fusoideae; paraphyses filiformes.

In foliis emortuis Alni.

Apothecia short stipitate, firm-fleshy, gregarious, 2–5 mm. in diameter, 1–2 mm. in height, "apricot orange" when fresh, "dragon's blood red" when dry, exuding a red juice when crushed in water, stipe slender, smooth, concolorous with the hymenium, exciple pseudoparenchymatic, cells thick-walled, hypothecium pseudoprosenchymatic; asci clavate, 8-spored, 35–60 × 7–8 μ, ascus pore J +; spores fusoid, hyaline, 1-celled, 7–8 × 3.5 μ, biseriate in the ascus; paraphyses filiform.

On decaying leaves of *Alnus* sp. Hoh River, Oregon, June 30, 1939, A. H. Smith *14710* (type). Additional collections A. H. Smith *13579,* Spruce, Washington on leaves of *Alnus* sp.; A. H. Smith *13509* on old leaves of *Acer* sp., Lake Quinault, Washington.

This is a common species in the western woods on old leaves of deciduous trees. The rich red color of the dried plants is very characteristic and in the fresh condition the bright yellow is no less so. A bright red juice is exuded when the fungus is crushed in water.

Ciboria tropicalis sp. nov.

Apothecia superficialia, alba, pallide alutacea exsiccata, subtilites furfuracea, 2 mm. lata, .5 mm. alta, pseudoparenchymatico; asci cylindriceo-clavati, apicibus latis, (80) 90–110 × 8–11 μ; sporae leves, hyalinae vel subhyalinae, nonseptatae, subalantoideae vel subfusoideae, 11–14 × 4–5 μ; paraphyses pausae.

In foliis emortuis Cocolobae (?).

Apothecia superficial, tough-waxy, solitary, short-stipitate, applanate, 2 mm. in diameter, white when fresh, pale alutaceous when dry, externally minutely furfuraceous, stipe .5 mm. in height, .5 mm. thick, expanding into the base of the disc, concolorous with the disc below, shading into pale brown upwards, hypothecium pseudoparenchymatic; asci cylindric-clavate, broadest at the apex, (80) 90–110 × 8–11 μ, 8-spored, ascus pore J +; spores smooth, hyaline to subhyaline, 1-celled, inequilateral, irregularly subalantoid-sub fusoid, 11–14 × 4–5 μ, filled uniformly with fine granular contents, uniseriate in the ascus; paraphyses scarce, filiform.

On veins on underside of fallen leaves of *Coccoloba* sp. (?), Valentin, British Honduras, June 24, 1936, E. B. Mains, *3582*.

When stained with iodine the hypothecial tissue and the ascus pore stain a bright blue color. The disc remains flat in the dry condition.

Coronellaria Castanopsidis sp. nov.

Apothecia sessilia, gregaria, superfilialia, 250–300 μ lata, asci lata clavati 45–55 (70) × 13–15 μ, latis membranis, 8 sporis; sporae hyalinae, 14–16 × 4 μ, pseudoseptatae, multeguttulatae; paraphyses filiformes, hyalinae, ramosae, laxum epithecium formentes.

In foliis emortuis Castanopsidis.

Apothecia sessile, gregarious, superficial, 250–300 μ in diameter, plane to slightly convex, soft waxy, smooth, "russett" outside, hymenium "pale cinnamon," exciple composed of irregularly hexagonal, dark brown cells at the base, the upper portion formed of elongated, thin-walled, subhyaline hyphae-like cells extending to the margin and forming a pallisade, hypothecium pseudoprosenchymatic; asci broadly clavate, 45–55 (70) × 13–15 μ, thick-walled, 8-spored, ascus pore broad, stained bright blue with iodine; spores hyaline, fusoid, 14–16 × 4 μ, spuriously septate, containing irregularly shaped guttulae, biseriate in the asci; paraphyses hyaline, filiform, branched above, extending beyond the asci and forming a loose epithecium.

On under side of leaves of *Castanopsis chrysophylla,* Mt. Hood, Oregon, October 14, 1922, C. H. Kauffman.

Dasyscyphella palmae sp. nov.

Apothecia gregaria, alba, 1 mm. lata, pallide brunneo-hirsuta, fasciculatis; pilis; asci cylindraceo-clavati 100–120 × 8–9 μ; sporae aciculares, hyalinae vel subhyalinae, multiseptatae; paraphyses numerosae, filiformes, hyalinae.

In putrescentibus petiolis palmarum.

Apothecia gregarious, white, short stipitate, 1 mm. in diameter, 1 mm. in height, hairs on the stipe and exciple rough, pale brown at the apices, fastened together in fascicles with a dark brown incrustation which adhers to the middle portion, capped with flat, cushion-like caps; asci cylindric-clavate, 100–120 × 8–9 μ, 8-spored, ascus pore J +; spores acicular, 60–95 × 2–3.5 μ hyaline to faintly greenish, many septate, breaking easily at the septa, completely filling the asci; paraphyses numerous, hyaline, filiform, 1.5 μ in diameter at the apices.

On decaying petioles of palm leaves, Valentin, El Cayo District, British Honduras, July 2, 1936, E. B. Mains *3712*.

A characteristic feature of this species is the braided appearance of the spores within the asci.

Helotium belisense sp. nov.

Apothecia solitaria, breviter stipitata 2 mm. lata, 1 mm. alta, albida, rubro-brunnea exsiccata; asci cylindriceo-clavati, 70–80 × 7–8 μ; sporae hyalinae, nonseptatae, fusoideo-ellipsoideae, suballantoideae, 7–8 × 3.5 μ; paraphyses filiformes, simplices vel ramosae.

In foliis emortius Ilicis.

Apothecia solitary, short stipitate, 2 mm. in diameter, 1 mm. high, fleshy-waxy, whitish tinged with brown when fresh, red-brown when dry, stipe concolorous with the hymenium, hypothecium pseudoparenchymatic, asci cylindric-clavate, 8-spored, 70–80 × 7–8 μ, ascus pore J +; spores hyaline, 1-celled, irregularly fusoid-ellipsoid, slightly allantoid, 7–8 × 3–3.5 μ; paraphyses filiform, simple or sometimes forked at some distance below the middle, 1.5 μ in diameter at the apex.

On under side of decaying leaves of *Ilex* sp., El Cayo District, Valentin, British Honduras, June 25, 1936, E. B. Mains *3606*.

Helotium Piceae (Kauff.) Kanouse, comb. nov.

From a collection made in Colorado on decaying needles of *Picea Engelmanii*, Doctor C. H. Kauffman (Papers Mich. Acad. Sci. **1**: 107. 1921.) published a description of *Helotium sulphuratum* (Schm.) Phill. var. *Piceae* Kauff. His comment upon the variety was, "This probably deserves more than a varietal rank." The chief difference between the species and the variety is the difference in spore size. In *H. sulphuratum* the measurements are given as 12–17 × 3–4.5 μ, in the variety *Piceae* they measure 10–12 × 5–6 μ.

On September 6, 1934, Dr. E. B. Mains collected a discomycete on fallen needles of *Picea canadensis* at Marquette, Michigan, which agrees well with Kauffman's Colorado material. The spore size is practically the same in the two collections of fungi. The results of a study made possible by having this additional material seems to confirm Dr. Kauffman's suggestion that the variety is

worthy of species ranking. The new combination *Helotium Piceae* (Kauff.) Kanouse is made for the fungus. The type is the Colorado fungus cited by Dr. Kauffman (l.c.). This together with the Michigan collection (Mains *34–60*) is deposited in the Herbarium of the University of Michigan.

Sarcosphaera gigantea (Rehm) Kanouse, comb. nov.

In 1899 Harper collected a fungus on Mackinac Island, Michigan, which Rehm (Ann. Myc. **3**: 517, 1905) described as *Pustularia gigantea*. By virtue of its apothecia which split geaster-like, it belongs to the genus *Sarcosphaera,* where Seaver (N. Am. Cup-Fungi 1928) has placed it. Seaver, however, considered it a synonym of *S. coronaria* (Jacq.) Schröt.

In July 1940 D. E. Stuntz and A. H. Smith collected specimens of a fungus from soil in Cascade Glen, Ann Arbor, Michigan, that agree closely with Rehm's account of *P. gigantea*. Like the fungi from Mackinac Island, the Ann Arbor specimens have spores that measure 10–12 × 6–7 μ whereas the spores of *S. coronaria* measure 15–18 × 8–9 μ. This difference is considered to be sufficient to establish Rehm's species. One would hesitate to place the Ann Arbor fungi in *S. coronaria*. The facts seem to justify a new combination for the small-spored fungus described by Dr. Rehm. Since it is unquestionably a valid species of *Sarcosphaera* the name *Sarcosphaera gigantea* (Rehm) Kanouse is applied to it.

Tryblidaria washingtonensis sp. nov.

Apothecia solitaria, sessilis, superficialia, .5–.75 mm. lata, subcarbonosea, nigra, applatatan exsiccati; asci cylindrici, 45–55 × 15–20 μ; sporae ellipsoideae vel subovoideae, muriformes, hyalinae vel subhyalinae, pallieo brunneae, 18–20 (30) × 7–8 μ; paraphyses crassae, septatae, hyalinae, membrana brunnea summae cellae.

In decorticato ligno et Physcia (?).

Apothecia solitary, sessile, superficial, .5–.75 mm. in diameter, subcarbonaceous, black, circular, applanate on drying, edge of disc slightly elevated; asci broadly cylindric, 8-spored, 45–55 × 15–20 (30) μ, ascus pore J +; spores ellipsoid, to slightly allantoid when young, narrowly subovoid ellipsoid when mature, thick-walled, slightly constricted at the median septum, muriform, hyaline to subhyaline when young, pale brown when mature, 18–22 (30) ×

7–8 μ; paraphyses stout, septate forming 3–4 elongated bead-like cells, the apical cell capped with a thick, dark brown wall.

On decorticated wood of *Chamaecyparis nootkatensis* and upon a foliose lichen (Physcia ?) growing upon the wood, Sol Duc Park Trail, Olympic Mountains, Washington, June 26, 1939, A. H. Smith *14487* (type): additional collection A. H. Smith *14486*.

Unguicularia oregonensis sp. nov.

Apothecia superficialia, cupuliformia, sessilia vel sub stipitata, minuta, 300–380 μ lata, alba, pilosa pseudoprosenchymatica, 35–50 × 7–8 μ, 8 sporis; sporae leves, hyalinae, non septatae, ellipsoideae, 7–8 × 3–3.5 μ; paraphyses filiformes, hyalinae, apice curvatae.

In stromatibus Eutypae.

Apothecia superficial, cupulate, sessile to substipitate, soft waxy, minute, 300–380 μ in diameter, white, clothed with hyaline, smooth hairs that are distinctly recurved at their apices, hypothecium pseudo prosenchymatic, pale brown in color; asci cylindric-clavate, 35–50 × 7–8 μ 8-spored; spores smooth, hyaline, 1-celled, ellipsoid, 7–8 × 3–3.5; paraphyses filiform, curved at the apices, hyaline.

Growing on the stroma of a *Eutypa* sp., Mount Hood, Oregon, 1500 ft. elevation; October 1, 1922, L. E. Wehmeyer.

The small size of the apothecia, the recurved hairs and paraphyses are the distinguishing characters of the genus *Unguicularia*. This species is distinct from the other known species of the genus.

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A NEW SPECIES OF CERATOSTOMELLA ON THE DATE PALM [1]

Donald E. Bliss

(with 11 figures)

Wilting and sudden death of mature date palms have been observed (1) in the Coachella Valley of California at various times during the last ten years. Among the fungi isolated from roots of affected palms is a species of *Chalaropsis* which in culture produces perithecia of the genus *Ceratostomella*. This fungus is described and identified in the present paper.

DESCRIPTION

Ceratostomella radicicola sp. nov.

Hyphae hyalinae, 3–10 μ in diam., septatae, ramosae; coloniae e griseis atrae.

Status Chalaropsis: Conidia dimorpha, endogena et exogena; endoconidiophora recta, hyalina, ampulliformia, 100–190 μ longa, 7–10 μ lata, 1–3-septata, ex apice endoconidia formantia; endoconidia continua, tenui-tunicata, hyalina, magnitudine variabilia, plerumque 8–15 $\times$ 6–10 μ, cylindrica apicibus truncatis vel rotundatis, catenulata, saepe in massas mucosas agglutinata; macroconidiophora procumbentia, hyalina, septata, sympodice ramosa; macroconidia exogena, hyalina dein olivaceo-fusco, crasse-tunicata, continua, ex ovata ovoidea basi truncata, plerumque 15–22 $\times$ 11–16 μ, singillatim in hyphis brevibus successive nata.

Status ascophorus: Perithecia lageniformia, solitaria; bulbus pallide tinctus, fere sphericus, 180–320 μ in diam., partim vel omnino immersus, mycelio laxo tectus; appendices e nullis multae, fuscae, varie ramosae, 35–90 μ longae; rostrum fuscidulum, apicem versus hyalinum et fimbriatum, attenuatum, 440–980 μ longum, 24–71 μ in diam.; asci deliquescentes, non visi; ascosporae hyalinae, ellipticae, lateribus inaequaliter convexis, continuae, 8–15 $\times$ 2.5–4 μ, tegumento mucoso vestitae, 8 vel pauciores in dispositione sectionibus aurantii simili glomeratae, extrusae et ad apicem rostri globum pellucidum formantia.

Hyphae hyaline, 3–10 μ in diameter, septate, branched; colonies gray to black.

[1] Paper no. 430, University of California Citrus Experiment Station, Riverside, California.

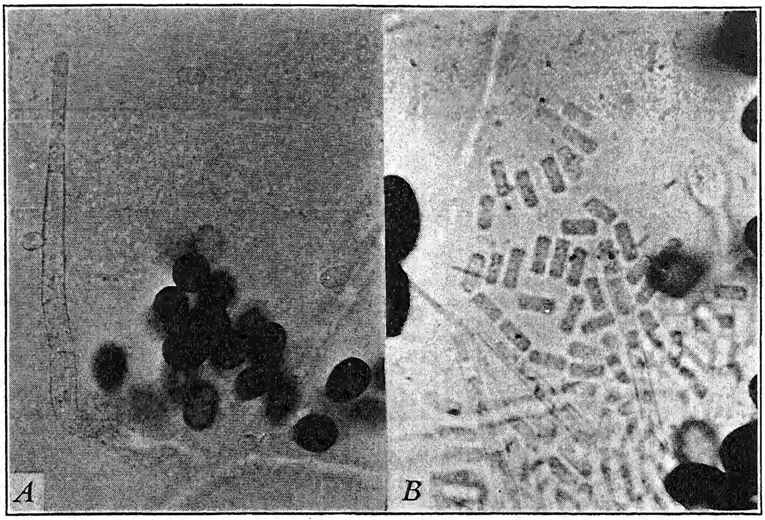

FIG. 1. *Ceratostomella radicicola.* *A,* endosporophore, with an endospore being pushed out at the tip and with a macrospore attached to the basal cell (× 395); *B,* endospores, showing cylindrical shape and general appearance when newly formed (× 867).

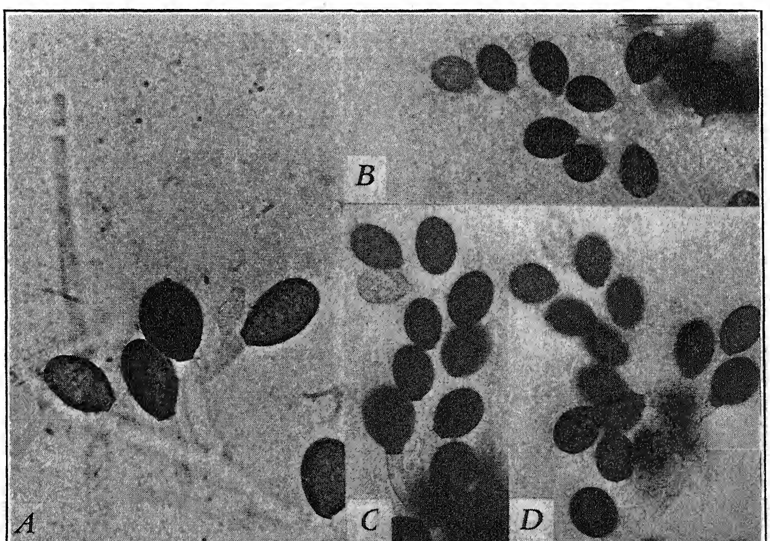

FIG. 2. *Ceratostomella radicicola.* *A,* young macrosporophore, showing the sympodial type of dichotomous branching and the acropetal succession in which the macrospores are formed (× 895); *B, C, D,* older macrosporophores (× 495).

Chalaropsis stage: Conidia of two kinds, endogenous and exogenous; endoconidiophores erect, hyaline, vase-shaped, 100–190 μ long, 7–10 μ wide, 1- to 3-septate, forming endogenous spores from tip; endoconidia continuous, thin-walled, hyaline, variable in size, mostly 8–15 $\times$ 6–10 μ, cylindrical with flattened or rounded ends, catenate, often collecting in slimy masses; macroconidiophores procumbent, hyaline, septate, with sympodial branching; macroconidia exogenous, hyaline then dark olive-brown, thick-walled, continuous, ovate to ovoid with a flattened base, mostly 15–22 $\times$ 11–16 μ, borne singly on short hyphae, maturing in acropetal succession.

Perfect stage: Perithecia flask-shaped, solitary; bulb faintly colored, nearly spherical, 180–320 μ in diameter, partially or completely submerged, covered with a loose weft of hyphae; appendages none to many, dark, variously branched, 35–90 μ long; beak dark colored, becoming hyaline and fimbriate at the apex, tapering, 440–980 μ long, 24–71 μ in diameter; asci deliquescent, not observed; ascospores hyaline, elliptical, sides unequally convex, continuous, 8–15 $\times$ 2.5–4 μ, covered with a mucous sheath, found in groups of 8 or less, standing side-by-side like the sections of an orange, extruded to form a pearly bead at the end of the beak.

Species heterothallic.

Habitat: Roots and trunk of *Phoenix dactylifera* L., Indio, California.

Types: Type specimens deposited with the Mycological Collections, Bureau of Plant Industry, Washington, D. C.; cotypes sent to the Farlow Herbarium, Harvard University, Cambridge, Massachusetts, and to the herbaria of the University of California at Berkeley, California, and at the University of California Citrus Experiment Station, Riverside, California. Mycelial culture placed at the Centraal Bureau voor Schimmelcultures, Baarn, Holland.

CULTURAL CHARACTERS

In pure culture the colonies vary from light gray to black in color, depending on their age and on the nature of the substrate.

FIG. 3. *Ceratostomella radicicola.* *A*, two mature endosporophores, showing the repeated division of the apical cell to form a chain of endospores; *B*, endospores, showing the wide variation in size and shape; *C*, mature, detached macrospores with heavy perispore wall, flattened end, and dense cytoplasm; *D*, macrosporophore with 8 spores formed in acropetal succession; *E*, young endosporophore; *F*, endosporophore with macrosporophore attached to the basal cell. (All $\times$ 923.)

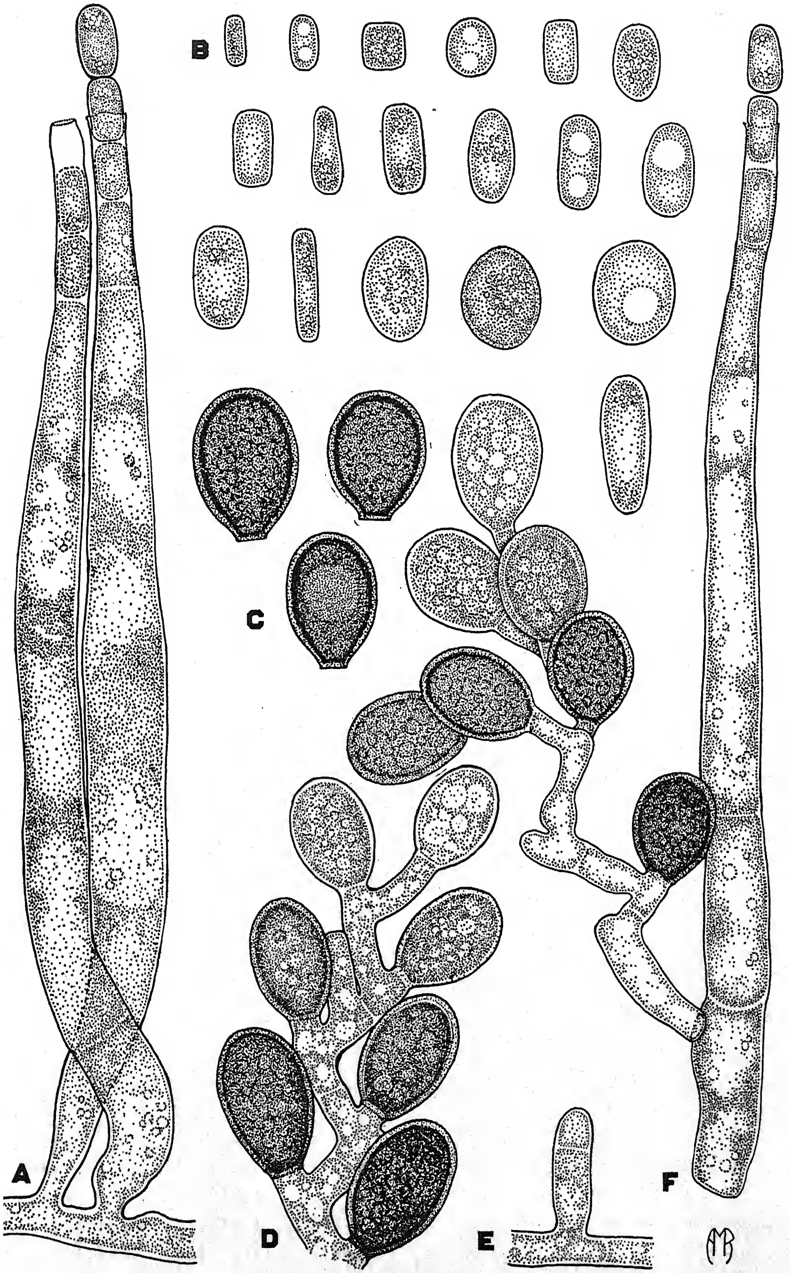

FIG. 3

Colonies with many macrospores are dark, while those in which endospores predominate or in which there is much aerial mycelium are light colored. Glucose-potato agar produces dense mycelial growth; corn-meal agar gives a comparatively sparse mat of hyphae.

The endosporophores (FIGS. 1, 3, and 4) consist of a basal cell and from one to three additional cells. The apical cell elongates greatly and produces many spores endogenously by repeated divisions of the protoplast. The tip of the sporophore is ruptured, and the endospores are pushed out in a long chain or in a droplet of slime, the procedure depending on the relative humidity of the air (FIG. 10).

Although usually hyaline, the endospores may become brownish with age. They are nearly cylindrical at first (FIG. 1, *B*), but the ends become rounded in the early stages of germination. The germ tube (FIG. 4, *I*, *J*, and *K*) may be lateral or terminal. Development of a new colony is very rapid under favorable circumstances. Young endosporophores (FIG. 4, *L*) are produced within a few hours from the time of spore germination, and macrospores appear only a little later.

The macrosporophores (FIGS. 2 and 3, *D* and *F*) exhibit the sympodial type of dichotomous branching that constitutes the principal diagnostic character of the genus *Chalaropsis*. This system of branching is indeterminate, but the total number of spores on one sporophore is usually not greater than 10. Although hyaline at first, the macrospores (FIG. 3, *C*) become darkened by the development of a dark, thick-walled perispore with a roughened surface. There is no tendency for macrospores to stick together in masses, as is the case with endospores and ascospores. At maturity the macrospore is filled with dense cytoplasm and often contains a large globule.

Germination of the macrospore results in the rupture of the perispore (FIG. 4, *A* and *B*) and the production of a germ tube. A vesicle (FIG. 4, *E* and *F*) may form if the spore does not free itself from the perispore. The thallus which develops from a macrospore cannot be distinguished from that of a germinated endospore. Endosporophores (FIG. 4, *G*) are differentiated from the germ tube almost immediately. Macrosporophores may branch from the

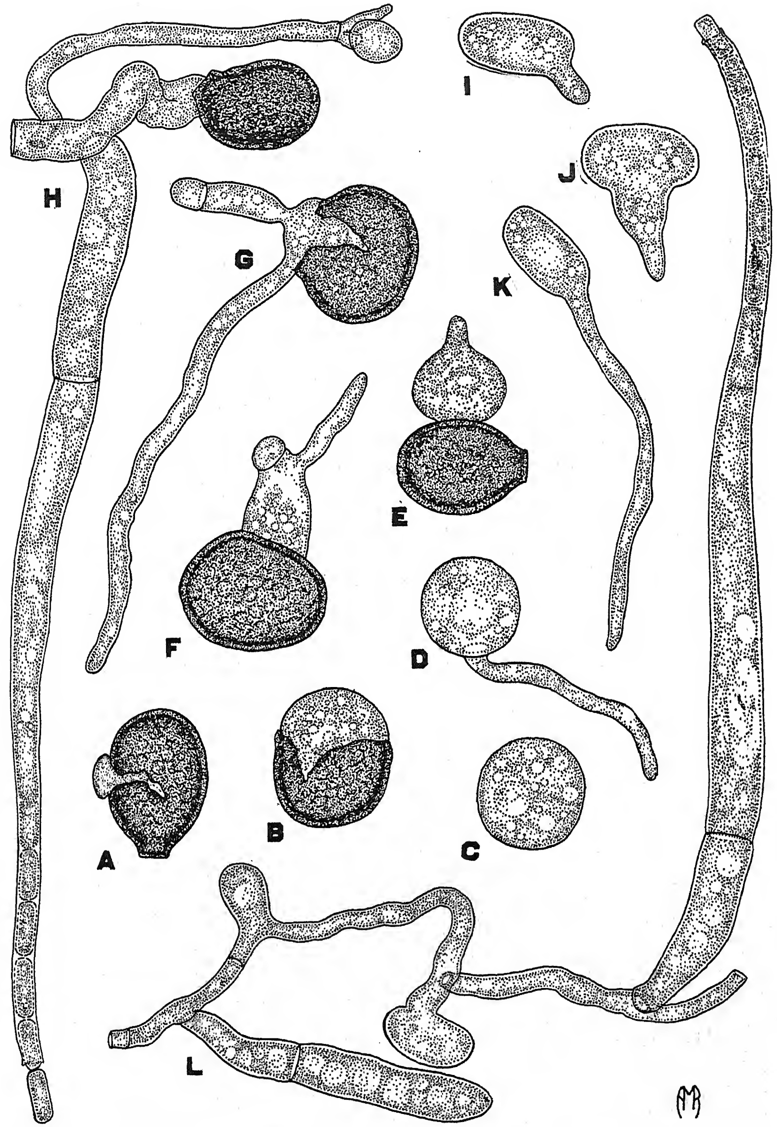

FIG. 4. Germinating asexual spores of *Ceratostomella radicicola* (× 923); *A, B,* macrospores with ruptured perispore; *C,* a macrospore freed from the perispore; *D,* a naked macrospore with germ tube; *E, F,* macrospores germinating by means of a vesicle; *G,* early stages in the development of the endosporophore; *H,* portion of a young thallus with a macrosporophore in an early stage of development; *I, J, K, L,* stages in the germination of endospores.

vegetative hypha (FIG. 4, *H*) or from the base of the endosporophore (FIG. 3, *F*).

The perithecia (FIGS. 5, *A*, and 7, *E*) are of typical *Sphaeronaema* form. They have been observed only on artificial media. The appendages (FIGS. 5, *B* and *C*, and 7, *B*) are located most commonly on the upper half of the bulb and sometimes form a ring about the base of the beak. They resemble the appendages of *Ceratostomella paradoxa* as described by Dade (3). The beak bears at the tip a fringe of hyaline hyphae (FIGS. 6, *B*, and 7, *A*) which measure 56–112 μ in length. These hyphae stand close together at first but separate to support the beadlike droplet of ascospores which are forced upward through the beak. The hyphae of the perithecium retain the ability to form endospores, although this is not commonly demonstrated.

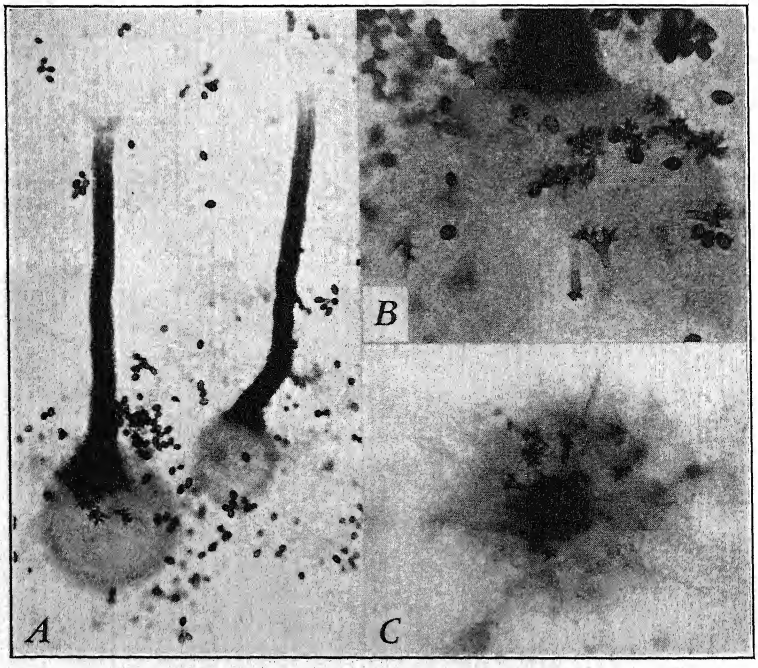

FIG. 5. *Ceratostomella radicicola*. *A*, two mature perithecia with spherical, slightly colored bulbs and long, darkened beaks ($\times$ 78); *B*, *C*, appendages on the bulb of the perithecium: *B*, side view ($\times$ 152); *C*, top view ($\times$ 115).

No walled ascus has been observed in the examination of this fungus. It is supposed that the asci deliquesce at an early stage in the development of the ascospores. When mature, these spores are extruded from the perithecial cavity to form a pearly bead at the end of the beak. The mucous sheath about each spore (FIGS.

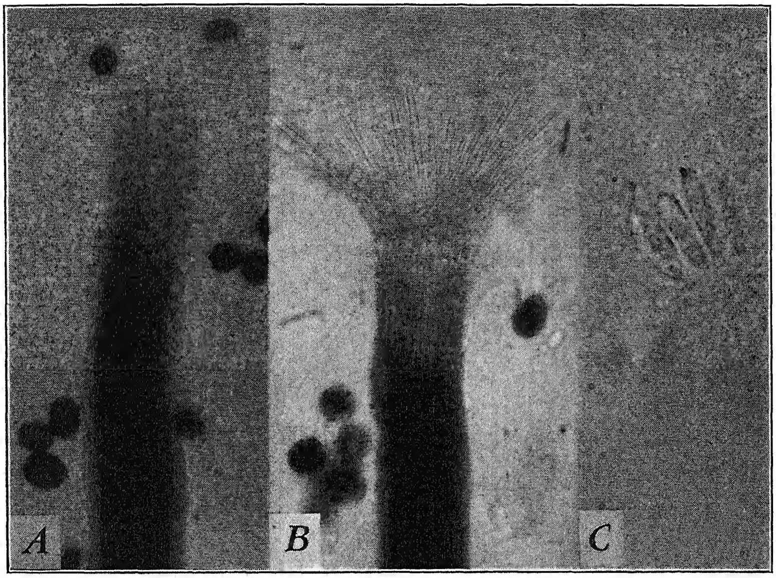

FIG. 6. *Ceratostomella radicicola.* *A,* apex of an unopened perithecial beak (× 332); *B,* apex of mature perithecial beak with fringe of hyaline, fingerlike hyphae opened by the extrusion of ascospores (× 332); *C,* group of ascospores held together by mucous (× 1050).

6, *C,* and 7, *C* and *D*) tends to hold the spores together even in the presence of water. This property makes it rather difficult to separate individual spores.

Heterothallism was demonstrated by mating certain single-spore cultures. In the first successful experiment, a culture from a single endospore was mated with a culture from a single macrospore. Perithecia formed along the line of union between the two colonies.

IDENTITY OF THE FUNGUS

The form genus *Chalaropsis* was erected in 1916 by Peyronel (11) on a type species called *C. thielavioides* Peyr. Similar fungi

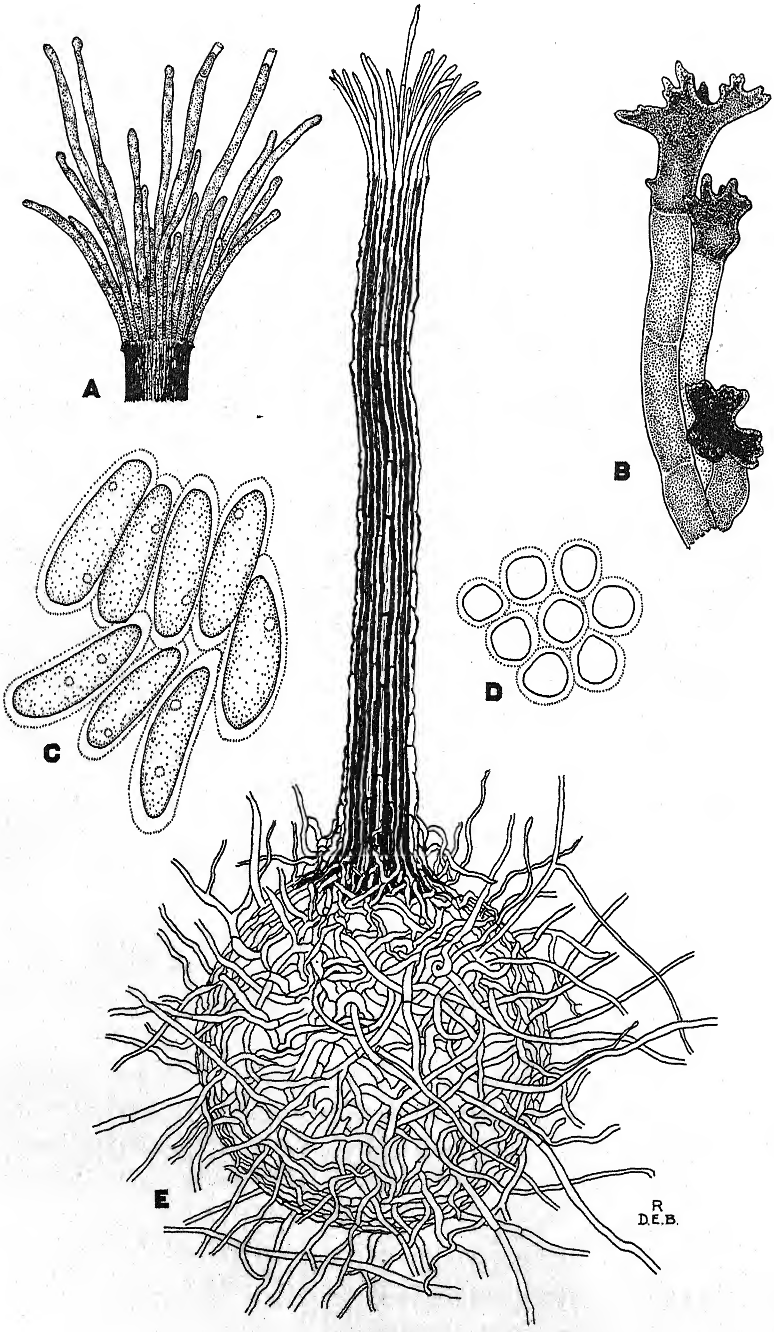

FIG. 7

have since been cultured (4, 5, 7, 8, 10) from various herbaceous and woody plants in Europe and the United States. All of these forms have been referred to *C. thielavioides*. Jackson and Sleeth (6) isolated "an endoconidiophora form of *Ceratostomella*" from *Platanus orientalis* L., which may also be related to these fungi. The *Chalaropsis* from date palms resembles the type species in

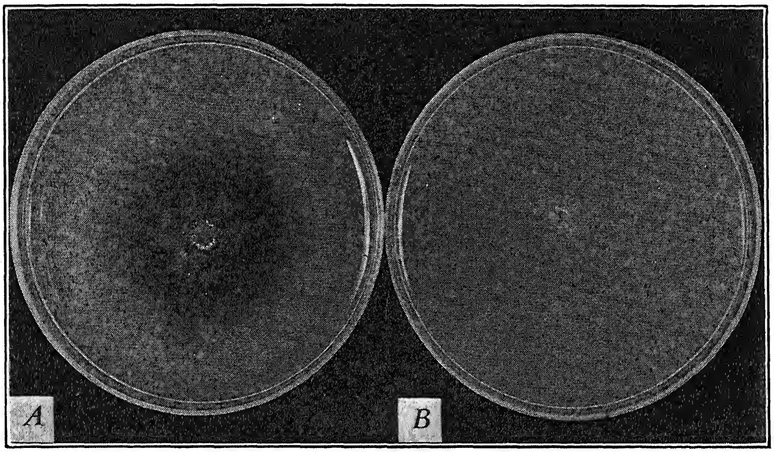

FIG. 8. Mycelial cultures on corn meal agar, incubated for 72 hours at 28° C. *A, Ceratostomella radicicola; B, Chalaropsis thielavioides.* (× 0.52.)

many respects, but because of the perfect stage and because of certain morphological and physiological differences, there seems to be good reason for creating a new species.

Comparisons between *Chalaropsis thielavioides* and the *Chalaropsis* from date palm were made on two mycelial cultures which had been held under identical conditions in the laboratory for a period of seven years. The culture of the type species had been isolated from *Lupinus albus* L. by Professor Peyronel in Italy; the other culture had been isolated by the writer from *Phoenix dactylifera* L. growing near Indio, California. It is thought that

FIG. 7. *Ceratostomella radicicola. A,* hyaline fringe at the apex of a perithecial beak, showing the formation of endospores in two hyphae (× 444); *B,* appendages from the perithecial bulb (× 1111); *C,* ascospores in side view (× 2056); *D,* ascospores in optical cross section (× 2056); *E,* perithecium (× 231).

the cultural characteristics of the two colonies had remained unchanged during this period.

When grown on corn-meal agar and incubated for 72 hours at 28° C., colonies of *Chalaropsis* from date palm developed much more rapidly than similar colonies of *C. thielavioides* (FIG. 8). The palm fungus produced an abundance of macrospores during that period, while the other fungus formed only a few. The relation of temperature to mycelial growth was further investigated (FIG. 9) in another series of petri-dish cultures. Seven chambers were employed, with constant temperatures ranging from 12° to 36° C. It was found that the growth rates of the two fungi were markedly different, that the temperature range of the date-palm fungus was wider than that of *C. thielavioides,* and that the optimum temperatures varied about 3° C. Other differences (FIG. 10) were noticed in the appearance of the two fungi when grown at 10° and 28° C. At the lower temperature the endospores of both fungi tended to clump together in masses of slime, while at the higher temperature long chains of spores remained intact. The masses of endospores from the date-palm fungus were very large in comparison with those of *C. thielavioides.*

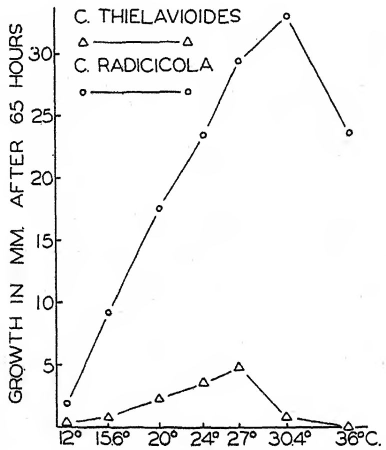

FIG. 9. Graph showing the growth-temperature relations of *Chalaropsis thielavioides* and *Ceratostomella radicicola.*

TABLE I

SIGNIFICANCE OF DIFFERENCES IN MEAN LENGTH AND MEAN WIDTH OF ASEXUAL SPORES OF *Chalaropsis thielavioides* AND *Ceratostomella radicicola* *

Culture	Endospores				Macrospores			
	Length (μ)		Width (μ)		Length (μ)		Width (μ)	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Ch. thielavioides, B-247	14.67	2.14	5.56	0.86	13.57	1.57	9.03	1.03
C. radicicola, B-261...	11.82	1.74	7.70	0.25	18.08	1.77	13.33	1.44
Difference between means............	2.85†		2.14†		4.51†		4.30†	

* Based on measurements of 120 spores each.
† Highly significant.

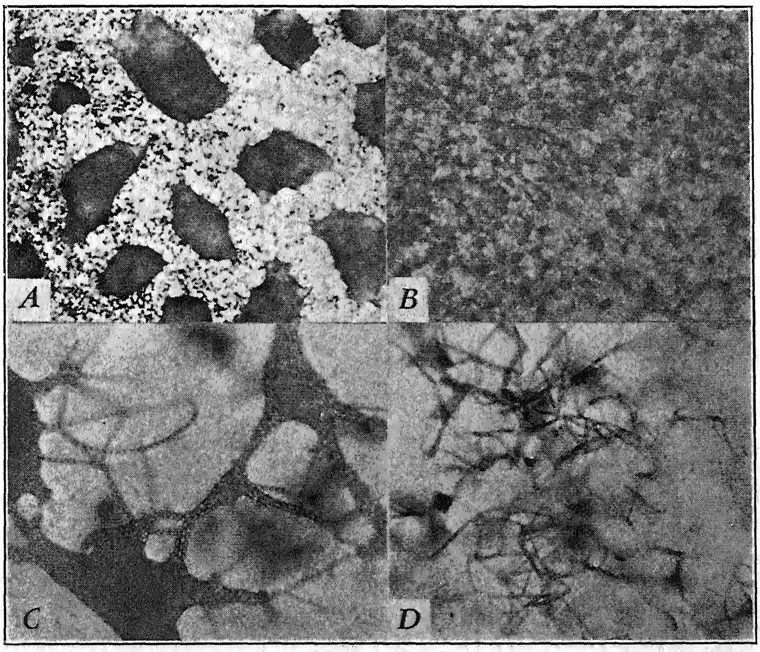

FIG. 10. Surface view of mycelial colonies, showing the effect of temperature on the tendency of the endospores to clump together in masses of slime. Cultures on corn meal agar, incubated for 72 hours; *A* and *B*, at 10° C. (× 28); *C* and *D*, at 28° C. (× 96). *A, C, Ceratostomella radicicola; B, D, Chalaropsis thielavioides.*

Studies were also made of the percentage distribution of different spore sizes (FIG. 11). The spores were taken from specially prepared petri-dish cultures on corn-meal agar, which had been incubated 20 to 25 days at 28° C. The measurements were made on a random sample of 120 spores in each case. When the

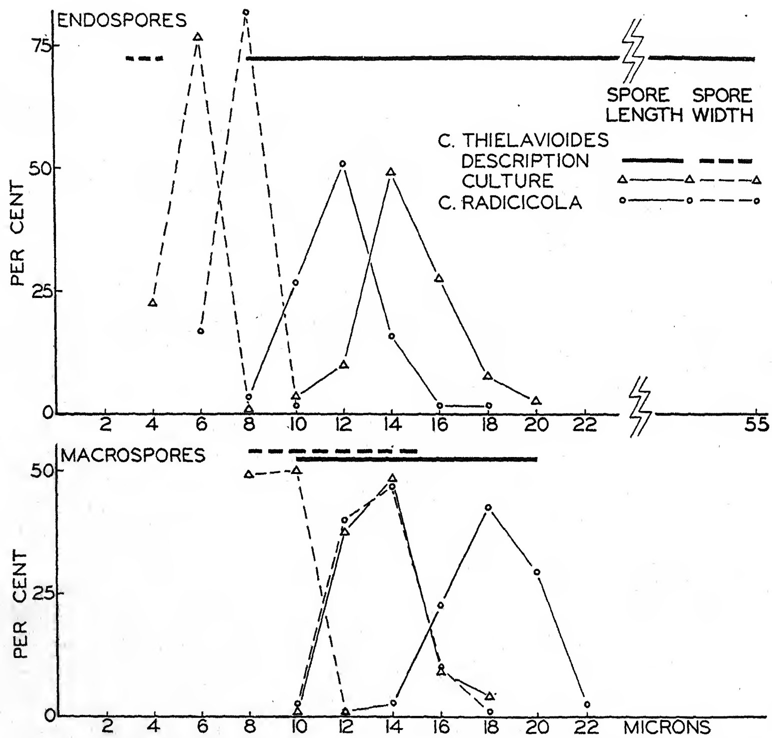

FIG. 11. Graphs showing percentage distribution of spore sizes of *Chalaropsis thielavioides* and *Ceratostomella radicicola*. Cultures were prepared on corn meal agar and incubated 20 to 25 days at 28° C. Each curve was based on the measurement of 120 spores. The heavy horizontal lines indicate the ranges of spore sizes as published by Peyronel (11) in his original description of *C. thielavioides*.

data for these distribution curves were treated statistically (Table I), the differences in the mean length and width of endospores and macrospores of the two species were found to be highly significant. All of these values were above the 1 per cent level of significance.

In other words, the probability that the difference was due to chance occurrence was less than 1 in 100.

In addition, the endosporophores of the date-palm fungus were found to be about twice as long as those of the type species.

Attempts to infect date palms with *Chalaropsis thielavioides* were unsuccessful. *Ceratostomella radicicola* was definitely parasitic on date palms but gave only slight evidence of pathogenicity on *Lupinus albus*.

DISCUSSION

The principal reason for erecting a new species for the fungus from date palm is that the perfect stage of this organism has been demonstrated. It has also been shown that the imperfect stage of this fungus differs in several ways from *Chalaropsis thielavioides*. Since no one has found an ascogenous stage associated with *C. thielavioides,* it would seem unwise to assume direct relationship with this new *Ceratostomella* unless the imperfect stages of the two could be shown to be identical.

Because of its attack upon the roots of the date palm, the new species has been named *Ceratostomella radicicola.* It is closely related to those species of the revised genus *Ophiostoma* H. and P. Sydow (**12**) and of the section *Longirostrata* Nannfeldt (**9**).

ACKNOWLEDGMENT

Appreciation is expressed for the assistance of Miss Edith K. Cash, who prepared the Latin description.

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NOTES ON THE SYNONYMY OF FRENCH AND AMERICAN AGARICS—II

Marcel Josserand and Alexander H. Smith

(with 4 figures)

Since publishing the first number (5) in this series, our investigations have been continued in so far as circumstances permitted. The eight pairs of names considered in the following text represent only a few of the species we have studied critically. Our study of *Cantharellus clavatus* and *C. multiplex* does not form a contribution to synonymy, but rather the opposite. We include it here, and plan to include other similar studies in the future, whenever they clear up important points concerning the identity and validity of closely related species. In our investigations we are continuing to follow the rules which we outlined in our first report. Consequently, in many groups of agarics in which it is difficult to recognize species either in America or Europe, we are withholding the results of our studies until such time as more complete information is at hand. This usually involves more field work, and, of course, it is impossible to predict when, if ever, we shall be able to obtain the necessary information to complete a particular group. Such delays are common knowledge to agaric specialists, but are not always understood by investigators in other fields.

The question of the existence of "parallel species" in Europe and North America is most difficult to study. Without a doubt there will be found numerous instances in which a geographical distinction is correlated with some minor but characteristic and constant morphological difference. As more information accumulates, however, the evidence points to the conclusion that in North America at least both members of a pair frequently occur. Hence a geographical distinction can be made only after exhaustive field studies and then not with absolute certainty. In some cases the supposed differences which appear to establish the existence of parallel species in America and Europe are revealed to be due to

inaccurate or inadequate descriptions on the part of either European or American authors. These situations are the ones which we are particularly interested in clarifying. In so doing we do not imply that mycologists of either continent have been negligent or careless as a group. Negligence or carelessness, we believe, are individual characters found about as frequently in one region as another, and are to be deplored wherever found.

As careful microscopic studies of American agarics progress, one is amazed at the number of valuable taxonomic characters discovered which aid either in reducing so-called American species to synonymy or establishing them beyond any possible doubt. The mere discovery of a peculiar anatomical character, however, is frequently not the end, but only the beginning of an investigation. For instance, the discovery by Smith (25) that *Tricholoma fallax* (Peck) Sacc. has a pseudo-hymeniform layer of pear-shaped cells forming the cuticle of the pileus, and that there is a second species practically identical with Peck's in appearance which has a perfectly homogeneous pileus, has raised the question of whether Peck's name has been correctly used by various European authors. If *T. fallax* were known only from North America, and the other species only from Europe, a clear case of "parallel species" might be established. Since both occur in the same habitat at the same time of the year in the same region, no such claim can be made.

Situations like the above make it very difficult for investigators to evaluate correctly the species described by the early workers of Europe. In addition, it frequently happens that several modern interpretations of the older European species exist, and an investigator in some other part of the world, if he is to continue his study, is forced to choose between them. If one considers these difficulties on the one hand, and on the other the additional trouble caused by incomplete and erroneous descriptions, the need for a study such as we are carrying out becomes clear indeed.

It should be added here that our study has been greatly facilitated by the suggestive specific names which have been given to many of the species in question. Names which suggest or emphasize the distinctive character of a plant are of great aid to investigators seeking to discover relationships and synonyms.

In the descriptions given in the following text the color names

in quotation marks are taken from R. Ridgway, Color Standards and Color Nomenclature, Washington, D. C., 1912. The specimens cited by number have been deposited in the Herbarium of the University of Michigan.

COLLYBIA MYRIADOPHYLLA (Peck) Sacc.: COLLYBIA TELEOIANTHINA Metrod (FIG. 3, *a*).

In our first paper (**5**) we pointed out that *C. lilacea* Quél. was a synonym of *C. myriadophylla*. Even as we established this synonymy another was suggested. Metrod (**13**) published *C. teleoianthina* as a new species. Its characters were the same as those of *C. myriadophylla* except that Metrod gave the spores as 8–9 $\times$ 3–4.5 μ. Those of *C. myriadophylla* are smaller and shorter (3.5) 3.8–4.3 (4.6) $\times$ 2.4–3 μ.

Because of this apparently important difference, Josserand was led to make a careful study of dried specimens which he obtained from M. Metrod for this purpose. An examination of the specimens showed the spores to be 3.8–5.3 $\times$ 2.3–2.6 μ, and in close agreement with those of Peck's species. Thus the only difference disappeared, and it was evident that *C. teleoianthina* was a synonym of *C. myriadophylla*, to which Metrod concurred in a letter to Josserand Dec. 3, 1837.

CANTHARELLUS MULTIPLEX Underwood: CANTHARELLUS CLAVATUS Fries.

Although the situation in regard to these two species does not involve a contribution to synonymy, we wish to take this opportunity to clarify a point which at present is still somewhat confused.

Mounce and Jackson (**14**) reported *C. multiplex* from Quebec stating that they believed their report to be the first record of the fungus since its description. Shope (**20**) reported it from Colorado and published a photograph as well as a description which was based on the specimens he collected. He cited the report of Mounce and Jackson as the only other record besides the original description. Overholts (**16**) called attention to Kauffman's dis-

cussion of *C. multiplex* and to the latter's statement of its distribution in western United States. Kauffman (8) believed that *C. multiplex* was merely a growth form of *C. clavatus*. Povah (18) reported *C. multiplex* for Michigan in 1935.

Shope (20) found that the spores of his specimens were similar to those of the type, a fragment of which he examined. He described them on p. 347 as "hyaline, irregularly globose to globose ovate, 4–6 $\times$ 4–6 μ, tuberculate. . . ." If this spore size is compared with that of *C. clavatus,* in which the spores regularly measure 9–12 $\times$ 5–6 μ, an important discrepancy in both shape and size is at once apparent. This discrepancy led us to question Kauffman's disposition of *C. multiplex*.

An examination of Kauffman's collections of *C. clavatus* and *C. multiplex* revealed that both had the same spores, 9–12 $\times$ 5–6 μ. Shope very kindly gave the junior author a slide from the type of *C. multiplex,* besides material from his Colorado collection. The spores in both were found to be as Shope had described them. Sections of the pileus were revived in KOH and were observed to change quickly to blackish green. This reaction was demonstrated on the sections of the type as well as on the Colorado specimens. No such color change occurred on any of Kauffman's collections filed under either name. It is evident that here are two very distinct characters which will serve to separate herbarium specimens of these fungi. Obviously, Kauffman confused a very luxuriant form of *C. clavatus* with *C. multiplex*—a mistake which could be made very easily since both apparently have about the same stature and much the same coloration. Kauffman's comments on the distribution of the latter therefore apply to the former. Povah's collection was also examined. The specimens proved to be *Pleurotus porrigens.*

As a result of this study it becomes apparent that Shope was the first to correctly report *C. multiplex* from Colorado. We have used the older names for both species here. In Europe *C. clavatus* is now better known as *Neurophyllum clavatum* (Fries) Pat. Since neither of us has seen fresh specimens of *C. multiplex,* it would be inappropriate for us to attempt to solve the question of its generic position at this time.

FLAMMULA SCAMBA (Fries) Sacc.: NAUCORIA CAESPITOSA Murr. (FIGS. 1, *g* and *h*; 3, *b*).

Flammula scamba has had a somewhat troubled history. For many years, in fact until quite recently, it was considered to be very close to *Paxillus tricholoma* and to differ chiefly in its glabrous pileus and lack of a fringed margin. Konrad (10) considered them to be conspecific and was supported in this belief by Dr. René Maire. Kauffman (7) mentioned *Paxillus scambus* in connection with *P. alienus* and was obviously adhering to the concept that it was close to *P. tricholoma*.

Comparatively recently, however, this concept was questioned by both Kühner and Lange who had collected a fungus which was much more in line with the Friesian descriptions. This later concept is now the one generally accepted by European investigators including Konrad and Maire. It seems to be generally agreed that there is only one European species in the *P. tricholoma* complex. It is quite different from the fungus referred to *F. scamba* by Kühner and Lange.

Smith (22) reported *Naucoria caespitosa* from California in 1937. This identification was checked by an examination of Murrill's type, and no attempt was made to place the fungus in *Flammula*. Since that time, however, attempts have been made to find the species in the European literature. A study of the European species of *Flammula* immediately brought to light the similarity between Murrill's fungus and the *Flammula scamba* (Fries) Sacc. sensu Lange, Kühner, etc. A careful study satisfied the junior author that *N. caespitosa* was identical with *F. scamba* of the above authors, and that the Friesian descriptions applied remarkably well to it. In order to be certain, however, dried specimens, notes and photographs were sent to M. Josserand. He was also convinced that the two were the same, but since he had not seen fresh specimens of the European species, the American specimens were turned over to Dr. Robert Kühner, who was also convinced that the two were identical. He pointed out that the apices of the cystidia in *N. caespitosa* were usually slightly incrusted, a character not shown by Konrad & Maublanc (11). However, Kühner stated that he had frequently observed such an

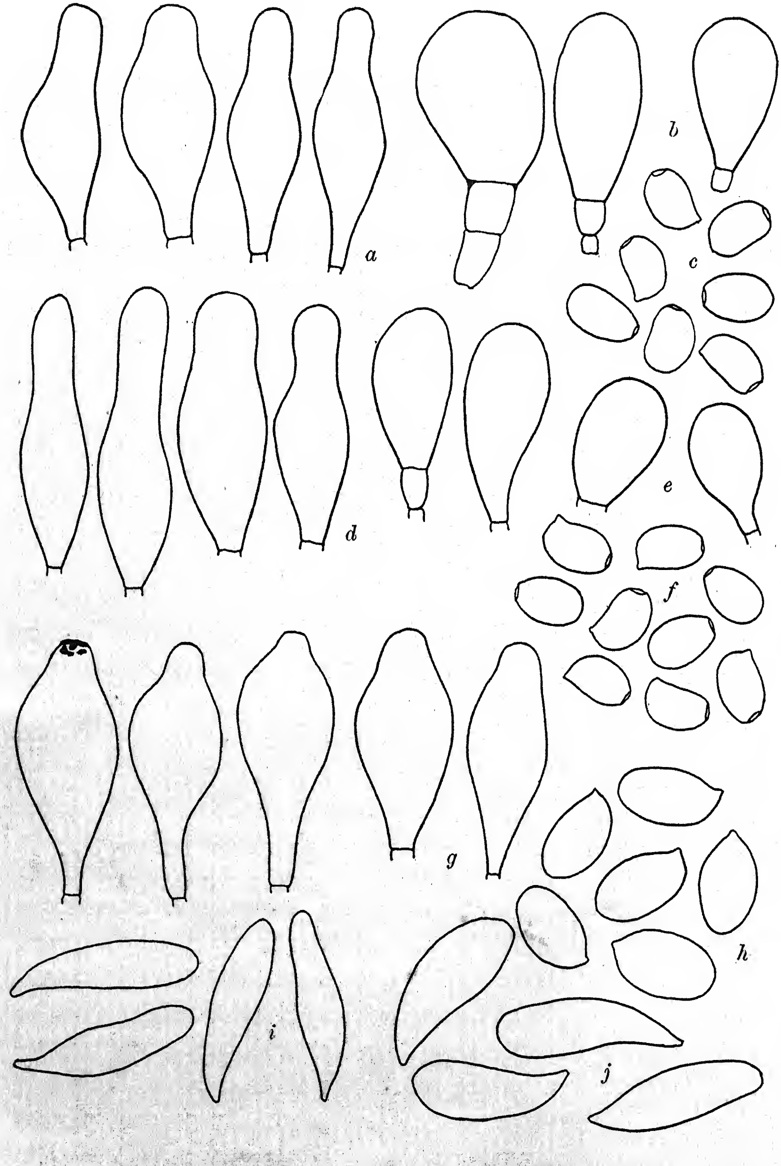

FIG. 1. Cystidia and spores of *Psathyrella hydrophila*, *Flammula scamba*, *Marasmius candidus* and *M. candidus* var. *setulosus*.

incrustation on the cystidia of his own specimens, and that consequently the presence of the encrusting material was not a difference between European and American specimens. Since there are no distinguishing characters, *N. caespitosa* should be regarded as a synonym of *F. scamba.*

In as much as this species has not been well known in North America, photographs of the fruiting bodies and drawings of the microscopic characters are given here along with a complete description. As the junior author has observed it in the western United States, it is more commonly densely gregarious than caespitose. It should also be found in northeastern United States and Canada.

Pileus 1–3.5 cm. broad, broadly convex or obtuse when young, becoming broadly convex to plane, with or without a low obtuse umbo, evenly "pinkish cinnamon" (pale buff) over all, surface at first covered by a mat of radially disposed fibrils which cause the margin to be fringed after the veil has broken, viscid when moist but soon dry, glabrescent, whitish in age; flesh very soft and watery, cartilaginous, sordid watery yellowish, odor not distinctive or faintly fragrant, taste none; lamellae close (26–32 reach the stipe), some forked near the base, in about three tiers, "cartridge buff" (whitish) in color, becoming sordid yellowish brown, moderately broad (3–3.5 mm.), tapering from the base to the margin or becoming slightly ventricose, horizontally adnate or developing a slight tooth, edges even; stipe short, 1.5–3 cm. long, 2–3 mm. thick, usually curved, equal, solid and fleshy, base with numerous "pinkish cinnamon" to whitish rhizomorphs and somewhat strigose at the point of attachment, lower three fourths densely fibrillose and peronate, the sheath soon broken up into floccose patches and eventually more or less disappearing, fibrils concolorous with those of the pileus, apex "sea-foam-yellow" (pale yellowish) and minutely squamulose, lower portion pale buff to somewhat yellowish.

Spores 7–9 $\times$ 4–5 μ, smooth, pale rusty brown under the microscope, subovoid, with a slightly thickened wall, apex not truncate; basidia four-spored; pleurocystidia abundant, hardly projecting beyond the hymenium, apices smooth or somewhat encrusted, ventricose in upper portion, abruptly narrowed to a broad rounded apex, with a distinct pedicel or sessile; cheilocystidia abundant, similar to pleurocystidia; gill-trama with a floccose central strand flanked on either side with narrow subgelatinous hyphae (which

appear glassy in KOH); pileus-trama homogeneous beneath a layer of brown-walled (in KOH) hyphae which are subgelatinous.

HEBELOMA SARCOPHYLLUM Peck: HEBELOMA PORPHYROSPORUM R. Maire.

In 1872 Peck described a *Hebeloma* which was unique in having reddish-incarnate gills and spores distinctly reddish in mass. Kauffman included the species in his Agaricaceae of Michigan and reëmphasized its unique characters. He reported it as infrequent. In 1931, Dr. R. Maire published *Hebeloma porphyrosporum,* a mushroom having the same outstanding characters as Peck's species.

Josserand, comparing the two descriptions, suggested that the species in question were conspecific. He had had an opportunity to study *H. porphyrosporum* in the fresh condition. The specimens were sent to him by Marcel Locquin and had been collected at Lentilly, near Lyon. Smith had collected *H. sarcophyllum* in Michigan so a joint study of both species was undertaken.

Three differences at first seemed to separate them. First, the pileus of *H. sarcophyllum* is paler than that of Maire's species. Peck described the pileus of his fungus as white, Kauffman (**6**) described it as "chalk white becoming dingy white." In his field notes Smith described it as white but soon becoming reddish gray. Maire (**12**) described *H. porphyrosporum* as follows: "cutis . . . albida disco rufo-ferrugineo suffusa, demum rufo-ferruginea, albido-marginata." In his study of *H. porphyrosporum,* Josserand noted "chapeau allant de creme-ivoire a beigeasse, a incarnat, a ocrace-incarnate, a ocrace-rosatre." This constitutes a difference, albeit a slight one.

Second, Peck did not indicate any cortina in his description. Kauffman (**6**) p. 480 stated "there is no cortina," and Smith in his notes stated "veil slight." Maire for his species noted "cortina alba" but added "fugacissima."

Third, there appears to be a slight difference in spore size. A study of Peck's type revealed that the spores measured 7–9 (10) $\times$ 4–5 μ. From a spore-deposit of a Michigan collection, Smith found the spores to be 8–10 $\times$ 4.5–5.5 μ. Kauffman gave the spores of Peck's species as 9–12 $\times$ 5–6 μ, somewhat larger than

in Peck's type. Smith, in studying Kauffman's collections found the range to be 9–12 (13) × 5.5–7 μ. Maire described the spores of his species as 11–15 × 5–6 μ. Josserand upon examining Maire's type found the average spore-size to be 11.2 × 6.6 μ. Those from M. Locquin's collection were 10.2–11.5 × 6.2–6.8 μ.

Since a difference in spore-size is the most significant character we discovered, we attempted to separate our various collections on that basis. A length of 10 μ appeared to be the dividing line. In Peck's species, on that basis, we would have the type and Smith's Michigan collection with a range below 10 μ, and all the other collections, including Kauffman's Michigan material, would have to be placed in Maire's species.

On the basis of a difference in spore-size, the slight color differences noted above and the supposed presence or absence of the cortina do not correlate. If primary emphasis were placed on either the color or the cortina, one still could not obtain a correlation. In view of the experience each of us has had in our own collecting grounds, we believe that the differences of color and development of the cortina are secondary characters very easily influenced by local conditions, and that since these differences between the two species under consideration are very slight, they should be regarded as simple variation.

The difference in spore-size may be significant, but here more data are needed to establish it. Actually very few collections of either species have been critically studied. In the genus *Mycena, M. amicta* and *M. subcaerulea* are recognized on the basis of a difference in both size and shape of their spores. In *M. capillaripes* and *M. haematopus,* Smith has observed differences in spore-size as great as that given above without attaching any particular taxonomic importance to them. Arnold (1) has studied a similar series of differences in *Marasmius elongatipes* Peck. She concluded from a study of mating reactions that the long-spored and short-spored forms, since they were interfertile, were best classified within the one species. In *Cortinarius,* where spore-size is used as a very important character, the difference we have noted between the two species of *Hebeloma,* if correlated with another difference, would be considered significant. However, in the hebelomas under consideration there is no correlated difference.

Consequently we believe that the character is not taxonomically significant and hence consider *H. porphyrosporum* to be a synonym of *H. sarcophyllum.*

MARASMIUS CANDIDUS Fries: MARASMIUS MAGNISPORUS Murr. (FIG. 2, *a*, *b*, and *c*).

Overholts (16) recently published a photograph and description of *M. magnisporus* Murr. As a result of this account and conversations with Overholts at the time of the foray of the Mycological Society in 1939, the junior author was able to identify a group of collections which had puzzled him a long time. The senior author recognized in Overholts' description and illustration a species well known to him in France as *M. candidus* Fries sensu Quél. Since Josserand had already sent specimens of *M. candidus* to Smith, the latter was able to make a critical study of the species in spite of conditions imposed by the war. In his communication, Josserand indicated that he believed that *M. candidus* sensu Quélet, Bataille and Boudier and *M. candidus* Fries were all conspecific with *M. candidus* sensu Hard (4) and *M. magnisporus* Murr. sensu Overholts. Since Hard gave the spore-size as $4 \times 2\ \mu$, his account cannot be considered further in connection with *M. magnisporus.*

In proceeding with a critical study of this situation, the junior author first compared the type of *M. magnisporus* with the material sent to him by Josserand. A study of small pilei in Murrill's type revealed that cheilocystidia and pleurocystidia were absent—Overholts stated " cystidia none " in his description. In the largest specimen examined, however, numerous cheilocystidia $60–150 \times 6–9\ (11)\ \mu$ were observed. In a few specimens the cheilocystidia were $30–50 \times 6–11\ \mu$, but showed a tendency to elongate. From this it was apparent that the cheilocystidia remain buried in the hymenium for some time and then elongate rapidly as the fruiting bodies near maturity. It should be noted here that in this species many small pilei usually accompany the larger individuals on a single stick. This character was well shown in Murrill's type. In studying the latter, all the fruiting bodies, both large and small, were taken from the same group in order to avoid possible errors. No pleurocystidia were observed on the older pilei of the type, but

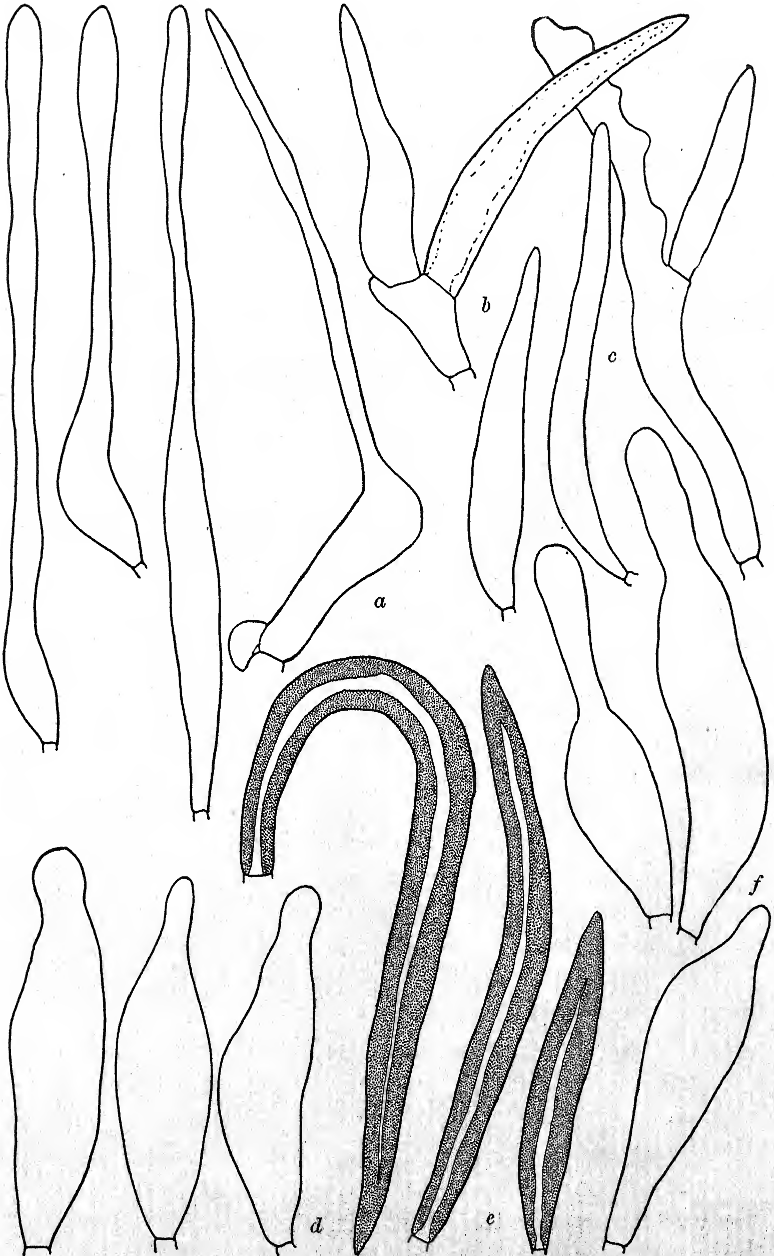

FIG. 2. Cystidia and setae of *Marasmius candidus* and *M. candidus* var. *setulosus*.

the pileus-trama appeared quite distinctive. The trama itself is of very loosely interwoven hyphae which are not at all gelatinous in consistency. Over the surface one finds a tangled mass of more or less elongated cystidia-like or greatly elongated hyaline cells some of which have slightly thickened walls. These do not form any sort of organized surface-covering. When young they are more or less upright and doubtless cause the pruinose appearance of the immature caps. In age they form a tangled, appressed, thin covering which, under a lens, appears finely fibrillose. The spores of the type were very variable in size, (10) 12–16 × 4.5–6 μ, and yellowish in iodine, as were all the tissues of the fruiting body. No brown-walled setae were found on the pilei though a special search was made for them.

Specimens from Josserand lacked the cheilocystidia but did have the same type of pileus-covering as that described above for Murrill's type. The spores were the same size and the dried fruiting bodies were indistinguishable. Both clearly showed the habit so well illustrated by Boudier (2). Since all of the pilei were rather small, the absence of cheilocystidia in the specimens from France is not a serious discrepancy in view of the above observations on Murrill's type. As a result of this study it was evident that Murrill's and Josserand's material represented the same species.

The junior author, however, had an accumulation of twelve collections from various parts of North America which complicated the situation. Eight of his collections from the Pacific coast checked well with Murrill's species except that pleurocystidia were sometimes present, particularly near the edges of the gills. In four of his collections from the Great Smoky Mts. National Park in Tenn., brown, thick-walled setae were found scattered over the surface of the pileus and pleurocystidia were generally abundant.

Among Kauffman's collections there is one identified by him as "*Marasmius candidus* Bolt." which is characterized by the brown setae on the pileus. It also has the abundant pleurocystidia and the narrow spores. Smith has been unable to demonstrate the presence of such setae on the specimens of *M. candidus* from France. An examination of Kauffman's notes showed that he had not observed the setae and had based his identification on Ricken's account of *M. candidus*. The hyaline pilocystidia ob-

served on the specimens from France and on Murrill's type were also present on the pilei of specimens possessing setae. A careful study of the western collections showed that they possessed occasional thick-walled hyaline or faintly yellowish setae as well as the thin-walled cystidia. In the search for setae on his specimens, Smith found it helpful to use lower magnifications when examining entire pilei and the usual high magnifications for examining sections. Under the former, the brown-walled setae showed up very well and their relative abundance on different pilei from the same or different collections was easily ascertained. Their distribution over a single pileus was found to be uneven and the number varied considerably in different pilei.

The disposition to be made of the southern collections involves the question of which of the conflicting concepts of *Marasmius candidus* of European authors should be accepted. Josserand wrote as follows on this point: I have made two notations concerning the *M. candidus* of authors: *M. candidus* sensu Pat. (Tab. Anal. Fung.) is surely not *M. candidus* of Fries. It is most certainly *Delicatula integrella!* I showed the plate to Kühner without telling him my opinion in order not to influence him, and he also stated emphatically that it was *D. integrella. M. candidus* sensu Lange (Fl. Agar. Dan.) is not *M. candidus* Fries, but probably *M. languidus* (translated from Josserand's letter of May 13, 1940).

Without question the concept of Quélet, Bataille and Boudier is the European concept most closely in line with the Friesian descriptions. However, the Friesian descriptions apply equally well to either of the American forms. In North America, before Murrill described *M. magnisporus,* fungi of this type were generally referred to *M. candidus* Fries, see Kellerman (**9**). Kauffman, to judge by his notes, also had accepted the European concept mentioned above. Thus the *M. candidus* of the French authors and that of certain American investigators is the same. Since this concept is perfectly in line with the Friesian description, we believe it is the one which should be generally adopted, and are thus forced to consider Murrill's name as a synonym of *M. candidus.*

For the collections characterized by the brown setae we propose the following variety:

Marasmius candidus var. **setulosus** var. nov. (FIG. 1, *i*; 2, *d*, *e*, and *f*).

Pileus albidus, setulosus; setae aciculares, ferruginosae, 40–200 × 6–10 μ; pleurocystidia 32–56 (100) × 8–15 μ, ventricosa vel subcylindrica; sporae (10) 12–14 × 3–4.5 μ.—Specimen typicum in Herb. Univ. of Mich. conservatum: legit prope Elkmont, Tenn. Aug. 8, 1938, A. H. Smith n. *9943*.

Pileus (5) 10–20 (25) mm. broad, convex to umbonate or nearly plane in age, the margin usually irregular and wavy, pure white, appearing glabrous, very thin, white, striate, becoming plicate in age or rugulose, soft and fragile (but drying rigid and reviving well), odor and taste none; lamellae white, very narrow, adnate, becoming free in age, distant, the short individuals reduced to veins and often the interspaces decidedly intervenose; stipe 1–2 cm. long, 1.5 mm. thick, equal or slightly enlarged above, short, terete, usually eccentric, white above, becoming blackish toward the base, appressed fibrillose to minutely pubescent, apex faintly silky, sometimes slightly striate, base rather conspicuously pubescent or surrounded by white mycelium.

Spores (10) 12–14 × 3–4.5 μ, hyaline, narrowly drop-shaped, yellowish in iodine; basidia four-spored; pleurocystidia and cheilocystidia similar, 32–56 (100) × 8–15 μ, irregular in shape, more or less fusoid-ventricose to cylindric, hyaline, smooth; gill-trama homogeneous, yellowish in iodine; pileus-trama homogeneous, loosely floccose, not gelatinous, with brown, thick-walled setae 40–200 × 6–10 μ scattered over the surface in addition to hyaline cystidia.

Singly to gregarious on sticks and debris of hemlock and tulip-trees, Tennessee and North Carolina.

When more is known of both the species and the variety, it will probably be discovered that the present apparent geographical distinction will disappear, and, that, like *Tricholoma fallax* and its counterpart, both occur in close proximity to each other during the same season. It is possible that the variety differs from the species in having a slightly different habit and slightly narrower spores in addition to the setae and pleurocystidia. These characters are likely to vary considerably however, and we do not wish to emphasize them without first examining a larger series of specimens. Since the junior author did not detect the difference between the variety and the species in the field, his observations on the fruiting bodies he has seen in central and southern United States, but not collected and preserved, are of no value.

In western United States, where only *M. candidus* has been collected, it has been found very abundantly, particularly in the Humid Transition life zone. In the dense thickets of elderberry and various species of *Rubus* along the coast a few miles south of the tip of Cape Flattery, Wash., where the canes of species of *Rubus*

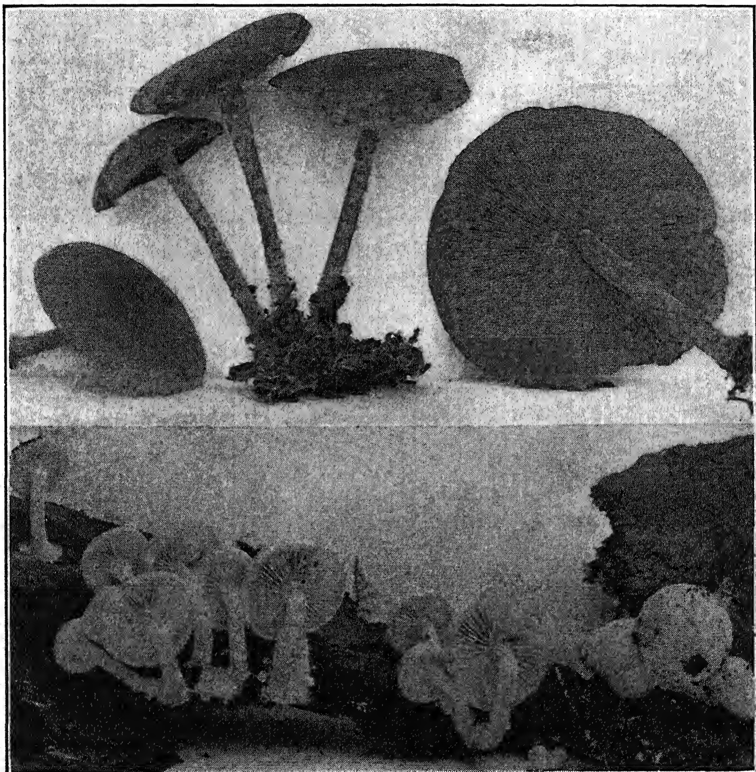

FIG. 3. Above, *Collybia myriadophylla* Peck × 1; below, *Flammula scamba* (Fries) Sacc.

attain a length of six to ten or twelve feet, specimens have been collected which measured 3–4 cm. across the pileus. These collections were lost in an accident. In collection no. *9496* from Crescent City, Calif., the largest specimen measured 3.5 cm. broad. This collection was from alder (*Alnus rubra*). Josserand reports that he has observed a variation of from 3–25 mm. in the size of

the pileus. One of the striking features of *M. candidus* is the large number of abortive fruiting bodies which are produced even under conditions which favor the development of the largest specimens cited above.

Smith's specimens confirmed the observations made by Overholts on the thickness of the stipe. In some the stipe is thickened above, but one is just as likely to find it equal.

MARASMIUS CHORDALIS Fries: MARASMIUS LIMONISPORA Kauff.

In 1925 Kauffman (8) described a *Marasmius* collected on the slopes of Mt. Hood, Ore., as *M. limonispora*. In addition to the somewhat ventricose spores, the species was characterized by having the stipe entirely pruinose, and in having cystidia on the faces and edges of the gills. After reading the description, Josserand believed that it could apply equally well to the previously described *M. chordalis* Fries and suggested this pair of names to the junior author as a subject for critical study. The study and discussion which followed was facilitated by the fact that both of us were familiar with *M. chordalis*.

Specimens reported as *M. chordalis* by Smith (23) were studied by Josserand who was convinced that the American material was the *M. chordalis* of Patouillard, Kühner and Josserand, Bresadola etc. Comparisons between the *M. chordalis* of the above authors and the Friesian descriptions brings out certain minor differences. Fries did not mention that the gills frequently stain reddish in age. However, Singer, who also knows this species, has examined dried specimens prepared by Robert Fries which were recognized as authentic by Elias Fries and found them "exactement identiques" with the *M. chordalis* of Kühner and Bresadola.

After verifying our concepts of *M. chordalis* we proceeded to a critical study of *M. limonispora.* Particular attention was given to the size and shape of the spores, the abundance, size and shape of both pleuro- and cheilocystidia, the nature of the cuticle covering the pileus and the type of pubescence covering the stipe. Kauffman's specimens were found to have the typical pseudo-hymneniform palisade of cells forming the cuticle of the cap and some of these were observed to have elongated at the apex to a filiform

appendage thus giving them the appearance of cystidia. Their presence causes the pilei of fresh specimens to appear pruinose. The pleurocystidia and cheilocystidia were also found to be similar in size, shape and abundance. The spores of both were found to be similar in shape and size and to become yellowish in iodine. In view of this evidence, we believe that *M. limonispora* should be regarded as a synonym of *M. chordalis.*

PSATHYRELLA HYDROPHILA (Fries) Smith: HYPHOLOMA CALIFORNICUM Earle. (FIG. 1, *a, b, c, d, e* and *f;* 4)

Psathyrella hydrophila is a common species both in France and the United States. Depending on the weather, it can be found on or around the wood and debris of hardwoods from midsummer to late fall. It has been fairly well characterized both in Europe and North America so a detailed description is not given here. There are several species which could be confused with it very easily. These are *P. madeodisca* (Peck) Smith, *P. chondroderma* (Berk.) Smith and *P. oblongispora* (Parker) Smith. Critical studies of these have been published, see Smith (24).

Parker (17) gave the distribution of *P. hydrophila* (*Hypholoma hydrophilum*) as extending from New York to Florida and west to Pennsylvania. The records in the University of Michigan Herbarium at the present time include material from Nova Scotia, New York, Maryland, Tennessee, Ontario, Michigan, Washington, Oregon and California. During the course of identifying his collections from California the junior author had occasion to consider a species described by Earle, *Hypholoma californicum.* A study of the type, C. F. Baker, no. *86,* was made. The study brought to light some interesting information.

Parker (17) recognized *H. californicum* as distinct from *H. hydrophilum* but gave no comments suggesting a close relationship. Since he (p. 206) reported *H. californicum* as occurring in conifer forests, it is possible that he regarded this a distinction between them. It is difficult to understand where Parker obtained his information. The original description by Earle (3) p. 344, states that *H. californicum* is " Densely caespitose on or near the base of oak stumps." This accurately describes both the habit and habitat

of *P. hydrophila*. In his study of the type of Earle's species the junior author found the spores to be as Earle described them, 5–6 $\times$ 3 μ. The blunt pleurocystidia were almost identical with those found on a specimen of *P. hydrophila,* which was communicated to the Univ. of Mich. Herbarium by Josserand. The characteristic layer of vesiculose cells which forms the cuticle of the pileus in these fragile dark-spored agarics was also similar in

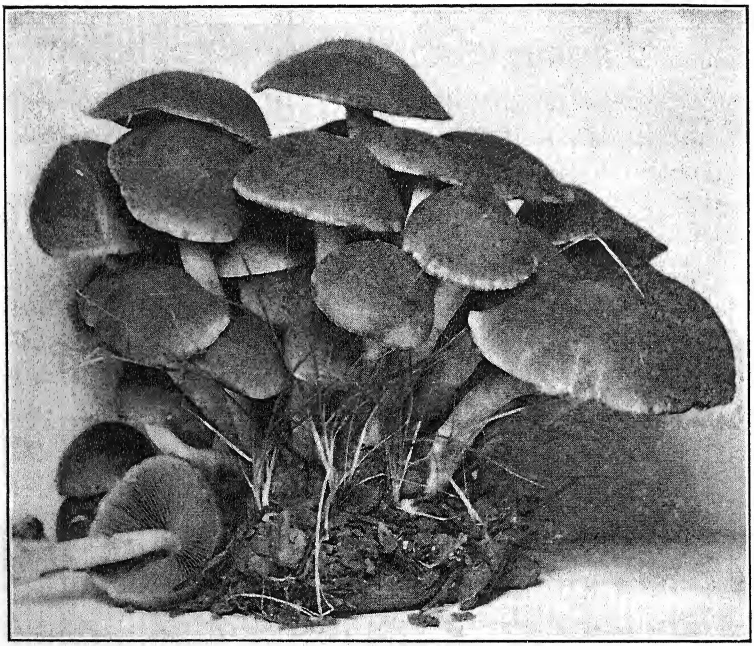

FIG. 4. *Psathyrella hydrophila* (Fries) Smith, slightly reduced.

both. The dried fruiting bodies of both were identical in appearance and consistency. However, since dried specimens in the genus *Psathyrella* all look very much alike and have the same consistency, this similarity is not as important as that between their microscopic characters. From this study it was apparent that the two were conspecific. This information along with camera-lucida drawings of the spores and cystidia was communicated to Josserand. Because of the outbreak of the war our correspondence was carried out largely by air mail and a further exchange of

specimens was not practical. After satisfying himself that Earle's species was not the same as *P. chondroderma,* the senior author agreed that *H. californicum* was not distinct from *P. hydrophila.*

Although this species is most sharply characterized by its microscopic characters, certain points concerning its gross features are pertinent to this study. The stipe of *H. californicum* was described as "uneven with small irregular swellings, sordid white, marked with brownish stains on drying." This suggests a similarity to *P. chondroderma.* In the latter, however, the stipe discolors as the fruiting body matures or ages. Stains such as Earle described are likely to appear on any species of *Psathyrella* as the specimens dry. The unevenness of the stipe is a secondary character which the junior author has found to be quite common with a number of species closely related to *P. hydrophila* and which was quite evident on the specimens illustrated in figure 3.

The colors of the moist pilei are quite variable in North American material. They are generally given as cinnamon brown to chestnut brown, and this is the range most commonly observed. However, specimens with very dark dull brown pilei ("mummy brown") occur as well as others with a more vinaceous cast ("verona brown"). The same general range of color variation observed for *Stropharia longistriata* Murr., see Smith (**24**), has been observed for *P. hydrophila.*

A certain amount of variability has been observed in the microscopic characters also. The spore-size though constant and distinctive varies somewhat. Measurements from a number of North American collections read as follows: $4–5 \times 2.5\ \mu$; $4–5 \times 2.5–3\ \mu$; $4.5–5 \times 3–3.5\ \mu$; $5–6 \times 3–3.5\ \mu$; $4.5–6 \times 3–3.5\ \mu$; Josserand has noted that in his spore-deposits the measurements are $5.6–7.6 \times 3.2–4.1\ \mu$. In his dried specimens however, they measure $5–6 \times 3–3.5\ \mu$. Ricken (**19**) has given the spore-size as $5–6 \times 2–3\ \mu$. The most interesting feature brought out by these measurements is that the spores of *H. californicum* are almost identical in size with the material from France whereas most of the collections from other parts of North America have spores which consistently range a bit smaller.

Kauffman (**6**) under *Hypholoma hydrophilum* sense of Ricken described the cystidia as "few or none." Smith has examined

Kauffman's specimens and found the pleurocystidia to vary in abundance. On certain collections from Ann Arbor they are very abundant and on others they are scattered to rare. Finally, the junior author's own collections have shown the same degree of variability in this character. The very obtuse apices of the pleurocystidia are their most important diagnostic feature.

Since we have not been able to find any character of recognized taxonomic value by which *H. californicum* can be distinguished from *P. hydrophila,* we have no hesitation in referring it to the latter as a synonym.

PHOLIOTA ERINACEA (Fries) Quél.: NAUCORIA BADIA Murr.

Naucoria badia was described from near Seattle, Wash. and has apparently not been recognized since from other regions in North America. During the summer of 1936 the junior author made a critical study of it while collecting with Prof. H. S. Jackson in the Lake Timagami region of Ontario, Canada. Since 1936 the type of *N. badia* has been critically studied and the Timagami material compared with it. The two were found to be identical. Prof. Jackson has found the fungus regularly for a number of years on twigs of hazel-nut bushes and of birch on Bear Island in Lake Timagami. The following description is based upon collections made on the island during the season of 1936.

Pileus 5–15 mm. broad, usually convex, sometimes slightly depressed on the disc or the disc slightly umbonate, surface dry and densely covered by fibrillose scales, the scales erect and almost spine-like on the disc, somewhat appressed toward the margin, the margin fimbriate with over-hanging fibrils, color "auburn," "russet" or "ochraceous tawny" (dark rusty brown to tawny), paler and more yellowish along the margin; flesh thin and fairly tenacious, pallid brownish, becoming whitish, odor not distinctive, taste not recorded; lamellae close to subdistant, broad, bluntly adnate, whitish, becoming pinkish-cinnamon or darker; stipe 8–15 mm. long, 1–2 (2.5) mm. thick, equal or the base somewhat enlarged, stuffed by a narrow pith, pliant and tough, lower portion densely squarrose scaly with fine fibrillose scales, somewhat silky above the fringe left by the broken veil, pallid brownish above, dark rusty red below.

Spores ellipsoid to subovoid, 7–9.5 (10) × 4–5.5 (6) μ in water-mounts of fresh material (slightly broader when revived in KOH), smooth, thin-walled, many collapsing, pale yellowish brown under the microscope in KOH; basidia four-spored; pleurocystidia none seen; cheilocystidia fusoid ventricose to filamentose, elongating and frequently branching in age, 20–35 × 6–9 μ; gill-trama homogeneous; pileus-trama with a surface layer of long, brown, thick-walled hyphae 5–7 μ in dia., and having free somewhat pointed tips, these hyphae septate and regularly with clamp connections, the remainder of the trama homogeneous.

A characteristic feature of this fungus is that the surface hyphae of the pileus in mounts of revived material either do not break up or if they do, they break up into long cylindric lengths usually the size of a single cell. The spores have a tendency to collapse quite readily and to become over-inflated when revived in weak KOH. Josserand has noted this same tendency in the spores of *Pholiota erinacea* of France.

If the above description is compared with that of *Pholiota erinacea* (*Naucoria* or *Phaeomarasmius* of some authors), a very striking resemblance is noted at once. American material was sent to M. Josserand who in return sent complete data including specimens to the junior author. We both arrived at the same conclusion, namely that the two were the same. However, one discrepancy was noted. In the European material the spores measure 8.5–11 × 6.5–8.5 μ and its basidia are one or two-spored. The American material so far examined has been consistently four-spored. It is apparent that here we are dealing with a simple variant-form comparable to those found frequently in the North American species of *Mycena* by Smith (**21**), and, as in *Mycena,* the difference in spore size which accompanies the change from the usual four-spored condition is not a taxonomically significant difference. *Naucoria badia* must therefore be regarded as a synonym of *Pholiota erinacea.*

SUMMARY

In the preceding account one new variety, *Marasmius candidus* var. *setulosus,* is described, and *Cantharellus multiplex* has been

reëstablished as a species distinct from *C. clavatus*. The following contributions to synonymy have been made:

1. *Flammula scamba* (Fries) Sacc. (=*Naucoria caespitosa* Murr.)
2. *Hebeloma sarcophyllum* Peck (=*Hebeloma porphyrosporum* Maire)
3. *Marasmius candidus* Fries (=*Marasmius magnisporus* Murr.)
4. *Marasmius chordalis* Fries (=*Marasmius limonispora* Kauff.)
5. *Pholiota erinacea* (Fries) Quél (=*Naucoria badia* Murr.)
6. *Psathyrella hydrophila* (Fries) Smith (=*Hypholoma californicum* Earle).

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DESCRIPTION OF FIGURES

The drawings were made with the aid of a camera-lucida and as reproduced the cystidia are approximately 980 × and the spores 1500 × natural size.

FIG. 1. *P. hydrophila* from Josserand, Lyon, France, *a*, pleurocystidia; *b*, cheilocystidia; *c*, spores. *H. californicum* (type), *d*, pleurocystidia; *e*, cheilocystidia; *f*, spores. *Flammula scamba*, *g*, pleurocystidia and *h*, spores. *Marasmius candidus* var. *setulosus*, *i*, spores. *M. magnisporus* Murr. (type); *j*, spores.

FIG. 2. *Marasmius magnisporus* Murr. (type), *a*, cheilocystidia, *b*, cystidia from the surface of the pileus. *M. candidus* var. *setulosus*, *d*, cheilocystidia; *e*, setae from the pileus, *f*, pleurocystidia.

A NEW POLYPORE IN WASHINGTON

ELIZABETH EATON MORSE

(WITH 5 FIGURES)

A stipitate polypore was observed and studied by Mr. J. B. Flett in Bremerton, Washington, from 1931 to 1939. It was first noticed because of its stature (up to 17 cm. tall), its exceedingly brittle and hygrophanous tissues and the bluish-green [1] coloration of the pilei.

Bremerton, as is well known, is located on a peninsula in sheltered Puget Sound, is well wooded and is subject to the heavy precipitation and dense fogs which prevail in that region. This fungus grew close to Mr. Flett's cabin in a more or less open *Pseudotsuga* forest, hence he was able to observe it day by day at all stages of development. It always appeared during the rainy seasons, though there were early and late arrivals in the months of September and March respectively. It grew in a thin layer of black humus 3 to 4 inches deep, unattached to living or decaying forest trees. This layer rested upon a deep substratum of sand and gravel, no clay present.

Mr. Flett watched an irregular Fairy Ring developing under cover of *Gaultheria, Vaccinium, Berberis* and *Rhododendron.* It advanced slowly where the vegetation was tall and dense, about 2 feet per year, but more rapidly on the open side of the ring—until a diameter of 75 feet was attained.

This fungus prospers best in semi-shade and when supplied with abundant moisture; the pilei become very brittle and snap like the crisp vein of a lettuce leaf!

The following description has been prepared from abundant material, extended correspondence, photo prints and the detailed notes supplied by Mr. Flett.

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[1] Aerugineus, Saccardo's *Chromotaxia*, no. 37, 1894.

Polyporus Flettii sp. nov.

Pileus circular or irregular by compression, crenate, undulate, 20×15 cm. broad in large specimens, at first convex, inrolled, later becoming plane and finally depressed at center; color when young greenish-blue, paler at margin, when dry becoming grayish or hoary, and finally dingy ochraceous; context white, 2 mm. thick at the margin increasing to 15 mm. at the center. Hymenium very shallow, separable from the context, pure white at first, becoming apricot to salmon when mature or dried, decurrent and ending in a reticulation on the stipe; at first covered with a spongy "superficial hyphal layer not involved in the process of tube formation," L. O. O.; tubes 1–4 to a mm., 1 mm. deep at margin to 7 mm. towards the stipe, mouths of tubes angular, not uniform; dissepiments dentate, becoming lacerate, finally fimbriate. Stipe smooth beyond the reticulation, white, solid, confluent with pileus, becoming dingy ochraceous when dry, up to 14 cm. long by 2–3.5 cm. wide, usually eccentric, often crooked from meeting obstructions or from caespitose manner of growth. Odor and taste farinaceous. Reported edible by Mr. Flett. Basidia clavate $12\text{–}16 \times 4\text{–}6\ \mu$, 4-spored; spores ellipsoid to subglobose, smooth, hyaline, uniguttulate, $3.5\text{–}4 \times 2.5\text{–}3\ \mu$. Cystidia and setae none.

Type locality. Bremerton, Washington, not reported elsewhere.

Habitat. In shallow black humus of mixed forest, even in gravel and moss.

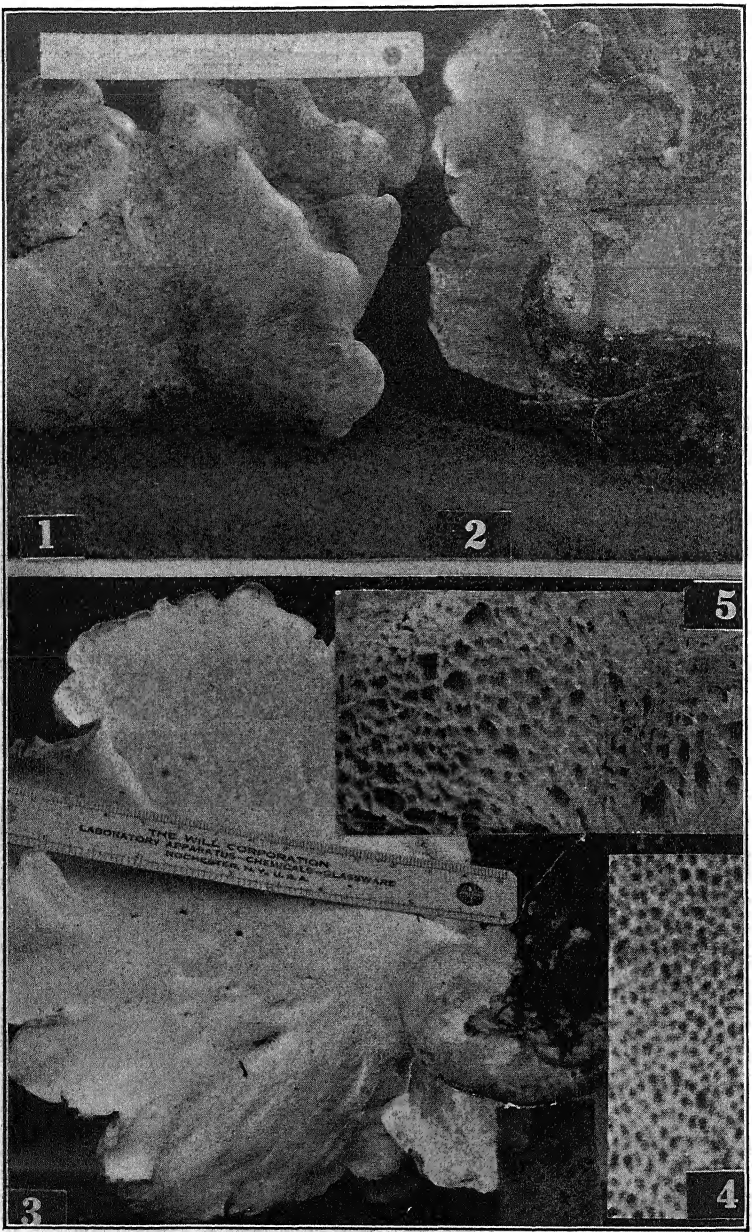
Habit. Gregarious, solitary, or caespitose.

Season. The rainy season, September to March.

Type collection deposited in Herbarium of the University of California as no. *589805*.

It is the opinion of L. O. Overholts that this fungus should be described as a new species (letter, May 25, 1936). Carleton Rea, England, comments as follows: "I do not know any species in England that will answer to your specimen" (letter, June 12, 1938). W. H. Snell writes: "Your fungus is without doubt a polypore and not a bolete. Separability of tubes is of no import even in the Boleti" (Feb. 3, 1941).

Grateful acknowledgments are made to Mr. Flett, as previously stated, and to those who examined specimens inclusive of Doctors Bonar, Overholts and Snell and Mrs. V. M. Miller. The writer



FIGS. 1–5. *Polyporus Flettii.*

earnestly hopes that other discoveries may be made and that opinions concerning this Washington polypore may be received.

CALIFORNIA MYCOLOGICAL SOCIETY,
UNIVERSITY OF CALIFORNIA,
BERKELEY, February 4, 1941

EXPLANATION OF FIGURES

FIGS. 1–5. *Polyporus Flettii* Morse: 1, Cluster of young sporophores, caps glabrous showing "bloom" easily marred, margins pale, crenate. 2, Under side of young sporophores, margins inrolled, hymenia covered with pure white spongy hyphal layer, mouths not yet opened out; stipes elongated, enlarged at bases, closely adjacent but not grown together. 3, Mature sporophore, margin expanded, thin, crenate, undulate; hymenial surface uneven, mouths opening out through hyphal layer; stipe elongated, ventricose. 4, Portion of pore surface enlarged, mouths open, shreds of hyphal layer intact. 5, Pores more enlarged, mouths angular, not uniform, dissepiments dentate, some lacerate, the most mature, fimbriate.

PEZICULA CARNEA AND PEZICULA SUBCARNEA [1]

J. Walton Groves [2]

(with 6 figures)

A number of species of *Dermatea* and *Pezicula* have been reported at various times as occurring on *Acer*. Two of these species, *Dermatea acerina* (Peck) Rehm and *Pezicula acericola* (Peck) Sacc., were recently described in detail by the writer (**1938**). Subsequently a third species, *P. carnea* (Cooke & Ellis) Rehm, was collected in abundance on *Acer rubrum* at the Mycological Foray held at Duchesnay, Que., in 1938. Studies based on cultures obtained from this material and from a collection made by Dr. L. O. Overholts at McKeever, New York, have confirmed the opinion expressed in the above-mentioned paper, that this species is distinct from *P. acericola*.

In addition to these a *Pezicula* has been collected on *Acer pennsylvanicum* in the Gatineau district north of Ottawa and in the Temagami Forest Reserve, Ontario, which is similar to *P. carnea* in gross appearance but differs in having much larger asci and ascospores and slightly larger conidia. This fungus does not agree with any of the species previously reported on *Acer* and is, therefore, described as new.

Cultures were obtained from both ascospores and conidia in each species and were grown on two per cent malt extract agar and on sterilized twigs of the host. The cultures from ascospores and conidia were similar in each species and both produced the same type of conidial stage in culture.

Pezicula carnea (Cooke & Ellis) Rehm, Ber. Bayer. Bot. Ges. **13**: 199. 1912.

Dermatea carnea Cooke & Ellis, Grevillea **5**: 32. 1876.

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[1] Contribution No. 665 from the Division of Botany and Plant Pathology, Science Service, Department of Agriculture, Ottawa, Canada.

[2] Graduate Assistant, Central Laboratory, Ottawa.

Dermatea simillima Ellis & Ev. Proc. Acad. Phila. **1893**: 451. 1894.

Dermatea carnea f. seriata Rehm, Ann. Myc. **9**: 1. 1911.

Dermatea quercina f. Aceris Rehm, Syd. Myc. March. *1579*. 1887.

Apothecia erumpent, gregarious to scattered, or more or less in rows, separate or in small clusters, at first rounded, then cylindrical, finally expanding at the tip into a circular disc, sessile, narrowed below, 0.3–0.8 mm. in diameter, 0.3–0.5 mm. in height, brittle, waxy in consistency, becoming more fleshy when moist; hymenium at first concave, becoming plane to slightly convex, slightly pruinose when dry, " light pinkish cinnamon " to " cinnamon," becoming brighter when moist, " light ochraceous buff " to " ochraceous buff," at first with a raised, paler margin which later disappears; tissue of the basal stroma compact, pseudoparenchymatous, composed of hyaline to yellowish, thick walled, irregular cells about 5–15 μ in diameter, arranged in more or less vertically parallel rows above, in the central part the cells becoming more elongated and interwoven, toward the outside the cells in more or less oblique rows, smaller and thicker walled, and darker colored; subhymenium a narrow zone of slender, interwoven hyphae about 1.5–2.5 μ in diameter; asci cylindric-clavate, short stalked, eight spored, (80)–90–110–(120) $\times$ (12)–15–18–(21) μ; ascospores oblong-ellipsoid to ovoid, one to four celled, straight or slightly curved, hyaline becoming slightly yellowish, biseriate, (15)–18–25–(30) $\times$ (5)–7–9–(10) μ; paraphyses hyaline, filiform, septate, simple or branched, 1.5–2.0 μ in diameter, the tips swollen up to 5–7 μ and forming a slight epithecium.

Conidial fruiting bodies minute, inconspicuous, developing beneath the outer bark layers and raising and splitting them, forming small, blister-like elevations but not breaking through, circular to somewhat elongated, about 250–700 μ in diameter, consisting of a more or less conical or cushion-shaped basal stroma, sometimes almost flat, varying in thickness from 10 μ to 100 μ or more in the thicker, central part, pseudoparenchymatous at the base, composed of hyaline, irregular cells about 5–10 μ in diameter, becoming more prosenchymatous above in the thicker part, the cells becoming more elongated and more or less vertically parallel or somewhat interwoven; conidiophores arising from the surface of the stroma, hyaline, cylindric, continuous or septate, simple, occasionally branched, 7–25 $\times$ 3–5 μ; conidia oblong-ellipsoid, hyaline, one or two celled, straight or slightly curved, slightly narrowed toward the ends, one end with a truncate apiculus, (18)–21–25–

(30) × (6)–7–9–(10) μ; microconidia hyaline, filiform, straight or curved, one celled, 5–10 × 1.2–1.5 μ.

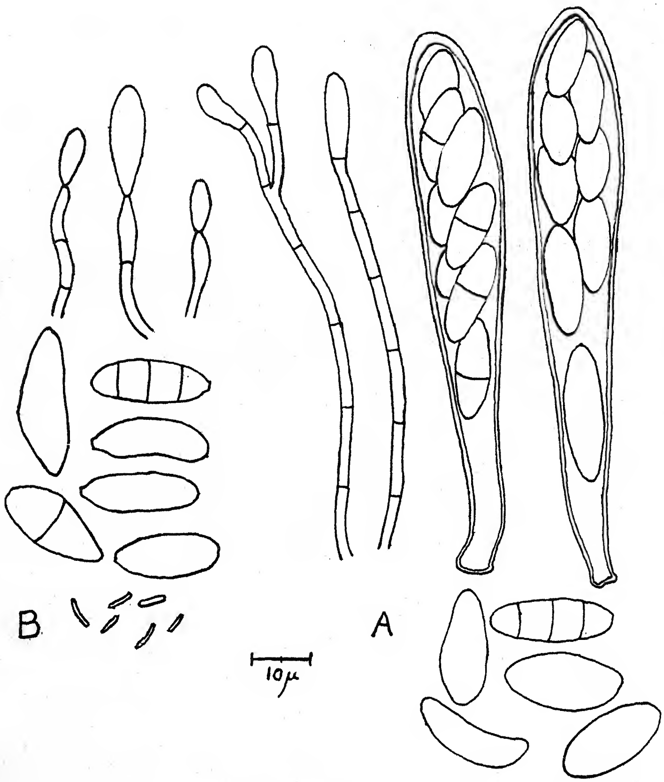


FIG. 1. *Pezicula carnea*. *A*, drawings of asci, ascospores, and paraphyses; *B*, conidiophores, conidia, and microconidia.

Host: *Acer* species, most commonly on *Acer rubrum* L.

EXSICCATI: Ellis, N. Am. Fungi *67a;* Fung. Columb. *246, 3420;* Rel. Farl. *112* (as *Dermatea acericola*); Rehm, Ascom. *1901* (as *Dermatea carnea f. seriata*); Sydow, Myc. March. *1579* (as *Dermatea quercina f. Aceris*).

SPECIMENS EXAMINED: Durand Herbarium. On *Acer rubrum*. *3790,* Newfield, N. J. J. B. Ellis *2339*. Part of the type. *7335,* Newfield, N. J. Coll. J. B. Ellis. *7412,* Newfield, N. J. Coll. J. B. Ellis. This specimen is part of the type of *Dermatea simillima* Ellis & Ev.

Mycological Herbarium of the Division of Botany and Plant Pathology, Department of Agriculture, Ottawa. On *Acer rubrum*. *5297* (*592*),[3] Duchesnay, Quebec—*5319* (*589*), McKeever, N. Y. Coll. L. O. Overholts *22130*.

University of Toronto Herbarium. On *Acer* sp. *2068*, Temagami Forest Reserve, Ont.

Herbarium of J. W. Groves. On *Acer rubrum*. *459*, Malloryville Bog, near Ithaca, N. Y. W. L. White *1625*—*506*, Mt. Lake, Va. Comm. E. K. Cash—*560*, Bottomless Pit, N. H. L. O. Overholts *20566*—*591*, Duchesnay, Que.—*676*, Kingston, N. J. L. O. Overholts *7880*—*680*, Center Co., Penn. L. O. Overholts *4630*—*681*, Huntingdon Co., Penn. L. O. Overholts *21325*—*698*, Oconee Demonstration Forest, Ga. Comm. G. E. Thompson. On *Acer* sp. *462*, Huntingdon Co., Penn. W. L. White *2381*—*619*, *699* (C. L. Shear *4172*), Duchesnay, Que.

On malt extract agar the colonies reach a diameter of 2–3.5 cm. in two weeks. They have a colorless, appressed margin and fairly abundant, fluffy-cottony, more or less tufted, aerial mycelium, white to buff or yellowish, often slightly greenish. The conidial fruiting bodies develop as rounded to irregular, fleshy stromata, about 1–3 mm. in diameter, covered with a sparse, downy, whitish to pale greenish-yellow mycelium, or almost glabrous and brownish, containing one or more irregularly lobed cavities which tear open irregularly and widely. The tissue is composed of closely interwoven, hyaline hyphae with the walls more or less grown together, looser at the outside and very compact around the cavities. The conidiophores and conidia are typical and microconidia are abundant.

On twigs of *Acer* a white to grayish-buff, fluffy-cottony, aerial mycelium develops around the point of inoculation and may spread rather sparsely over the twig. The conidial fruiting bodies are erumpent, rounded to almost globose, white to buff or yellowish, covered with a downy, aerial mycelium, firm, fleshy in consistency, 0.4–1.0 mm. in diameter and usually about 0.5 mm. in height, containing one or more rounded to more or less chambered cavities in the upper part. The basal stroma is thicker than in nature but

[3] The numbers in parentheses refer to duplicate specimens in the herbarium of J. W. Groves.

the tissue structure is similar. The conidiophores, conidia, and microconidia are typical.

Pezicula carnea was originally described by Cooke and Ellis (**1876**) as *Dermatea carnea* and was transferred to *Pezicula* by Rehm (**1912**), who listed *P. acericola* (Peck) Sacc. as a synonym. It was regarded as a synonym of *P. acericola* by Seaver and Velasquez (**1933**) and of *P. cinnamomea* (DC.) Sacc. by Wollenweber (**1939**).

The writer is convinced from an examination of type material of *P. acericola* and *P. carnea,* and from a comparison of cultures from ascospores and conidia of both fungi, that these should be regarded as two distinct species. *P. acericola* differs from *P. carnea* in its larger, more caespitose, more strongly erumpent, and brighter yellow apothecia, slightly broader asci, slightly larger ascospores, and definitely larger conidia. Cultures of *P. acericola* are white, occasionally buff to brownish, with abundant fluffy aerial mycelium, while cultures of *P. carnea* usually show greenish to yellowish tints and the aerial mycelium is less abundant and more tufted than in *P. acericola.*

It is evident from an examination of the available exsiccati cited by Seaver and Velasquez (**1933**) and from their figures and the description of their cultures, that they did not have the true *P. acericola* but were dealing only with *P. carnea.*

They observed this *Pezicula* growing in close association with pycnidia of *Sphaeronema acerinum* Peck and apothecia of *Dermatea acerina* (Peck) Rehm, and inferred that all three were stages of the same organism. The writer has observed this association in several collections and in the Duchesnay material it was very striking. However, cultures from ascospores of the *Dermatea* and conidia of the *Sphaeronema* proved to be identical with each other and different from cultures from ascospores of *P. carnea,* and when twigs bearing apothecia of *P. carnea* were placed in a moist chamber, spore masses of an inconspicuous *Cryptosporiopsis* appeared. Cultures from these conidia were identical with cultures from ascospores of *P. carnea.* These conidia are narrower and more pointed at the ends than conidia of *Sphaeronema acerinum* and, of course, are borne in an entirely different type of fruiting body. The association between apothecia of *P. carnea* and

pycnidia of *Sphaeronema acerinum* is, therefore, only one of chance and the true conidial stage of *P. carnea* is the *Cryptosporiopsis*.

Von Höhnel (1916) evidently observed this association also when he suggested that *S. acerinum* was the conidial stage of *Dermatea simillima* Ellis & Ev. Examination of part of the type of *D. simillima* in the Durand Herbarium disclosed that it was identical with *P. carnea.*

The taxonomy of *Pezicula cinnamomea* is in a state of confusion. Persoon (1801) described a *Peziza diluta β cinnamomea* but the description was too incomplete for the fungus to be recognizable and no host was mentioned. DeCandolle (1815) described a fungus occurring on oak as *Peziza cinnamomea* and this description might well apply to a *Pezicula.* Persoon (1822) again described a *Peziza cinnamomea,* this time giving the host as oak and citing DeCandolle's description, thus indicating that he considered his fungus to be the same species. Since, according to the International Rules, the priority of specific names dates from Fries' Systema Mycologicum, it should be noted that here *Peziza cinnamomea* was described as occurring on oak and the descriptions of DeCandolle and Persoon (1822) were cited. The combination *Pezicula cinnamomea* was published by Saccardo (1881).

Berkeley (1881) reported a fungus on maple as *Dermatea cinnamomea* (DC.). He evidently considered that he had DeCandolle's fungus, and there would seem to be no justification for the later appearance in the literature of the combination *Dermatea cinnamomea* Berk. & Br. for a fungus on maple.

Dermatea cinnamomea Cooke & Peck on *Populus* is a synonym of *Ocellaria ocellata* (Pers.) Schroet.

Tulasne (1865) described a *Pezicula* occurring on oak as *Pezicula amoena.* He observed a conidial stage associated with the apothecia and it is noteworthy that he described the conidia as narrower or about the same width as the ascospores. Fuckel (1869) also described a *Pezicula* on oak as *P. quercina.* Later (1874) he reported a fungus on *Alnus* without describing it, as *P. quercina* var. *Alni,* and a specimen on *Acer pseudoplatanus* was distributed in Syd. Myc. March. *1579* under the name *P. quercina* f. *Aceris* Rehm. Rehm (1889) described the *Alnus* fungus as a

distinct species, *P. Alni,* but retained the *Acer* fungus as a form of *P. Alni.* Later (1896) he listed it as a synonym of *P. acericola,* a treatment followed by the writer (1938). However, examination of the specimen in Syd. Myc. March. *1579* has subsequently shown that it is *P. carnea* and not *P. acericola.*

Wollenweber (1939) has brought together as synonyms under the name *P. cinnamomea,* such diverse forms as *P. Alni* Rehm, *P. aurantiaca* Rehm, *P. acericola* (Peck) Sacc., *P. carnea* (Cooke & Ellis) Rehm, *Dermatea acerina* (Peck) Rehm, and others. He did not study all these forms in culture, nor did he examine the types.

P. Alni and *P. aurantiaca* were recently described in detail by the writer (1940). It was shown that they are clearly distinct specifically and if the genus *Ocellaria* is recognised, *P. aurantiaca* could with equal justice be placed here and separated generically. Similarly with the species occurring on *Acer, Dermatea acerina* must be regarded as not only specifically, but generically distinct from *P. acericola* and *P. carnea.* The latter two can readily be separated from each other, and obviously all of these forms cannot be identical with *P. cinnamomea.*

It has not been possible to examine the types of the *Pezicula* species described on oak, and the taxonomy of these species is still not clear, but it seems certain that *P. cinnamomea* is a valid name for one of them. A culture, isolated by Jørgensen and labelled *P. cinnamomea,* was obtained from the Centraalbureau voor Schimmelcultures at Baarn. It produced both perfect and imperfect stages when grown on twigs of *Quercus* in flask cultures. Wollenweber (1939, p. *542*) evidently studied this same culture and considered it to be *P. cinnamomea.* However, it is very different in cultural characters and in size of conidia from *P. carnea.* The conidia are, in fact, wider than the ascospores, which would even seem to preclude the possibility of its being identical with *P. amoena* Tul.

A *Pezicula* has been collected on oak in the Temagami Forest Reserve, Ontario, and at the Petawawa Forest Experiment Station, Ontario, and this species also differs from the Baarn culture in cultural characters and in size of conidia. It also appears to be different from *P. carnea,* and may be *P. amoena* Tul.

All of the species listed as synonyms of *P. cinnamomea* by Wollenweber which the writer has studied in culture, *i.e., P. Alni, P. aurantiaca, P. acericola, P. carnea,* and *Dermatea acerina* have proved to be clearly distinct from Wollenweber's concept of *P. cinnamomea* as represented by the Jørgensen culture from Baarn, and also from the *Pezicula* collected on oak in Ontario. It would seem, therefore, that much more convincing proof than Wollenweber has offered should be forthcoming before his list of synonyms be accepted.

Pezicula subcarnea sp. nov.

Apotheciis erumpentibus, gregariis vel dispersis, plus minus seriatim instructis, solitariis vel caespitosis, orbicularibus, sessilibus, versus basim attenuatis, 0.4–0.8 mm. latis, 0.2–0.5 mm. altis, mollibus, ceraceis, in humido carnosis; hymenio plano vel convexo, leviter pruinoso, ochraceo, margine primum elevato, pallide, dein evanescente; hypothecio pseudoparenchymato; ascis clavatis, latis, breve stipitatis, octosporis, (90)–100–130–(150) × (21)–23–28–(30) μ; ascosporis elliptico-oblongis vel ovoideis, hyalinis vel luteolis, rectis vel leviter curvatis, continuis vel triseptatis, irrgulariter biseriatis, (21)–25–35–(40) × (10)–12–14–(16) μ; paraphysibus hyalinis, filiformibus, septatis, simplicibus vel ramosis, 1.5–2.0 μ diam., apice ad 5 μ incrassato, leve epithecium formantibus.

Hab. *Acer pennsylvanicum* L.

Apothecia erumpent, gregarious to scattered or more or less in rows, separate or in small clusters of two to six, circular, sessile, narrowed below, 0.4–0.8 mm. in diameter, 0.2–0.5 mm. in height, soft, brittle, waxy in consistency, becoming more fleshy when moist; hymenium plane to convex, slightly pruinose, close to "tawny" or "ochraceous" in color, brighter when moist, "zinc orange" to "ochraceous orange," the margin paler, at first slightly raised, then disappearing; tissue of the basal stroma compact, pseudoparenchymatous, composed of hyaline to pale yellowish, fairly thick walled, almost isodiametric cells 8–12 μ in diameter, arranged in more or less vertically parallel rows, curving obliquely toward the outside where the cells are darker and thicker walled; subhymenium a narrow zone of closely interwoven, indistinct hyphae; asci broadly clavate, short stalked, eight spored, (90)–100–130–(150) × (21)–23–28–(30) μ; ascospores oblong-ellipsoid to ovoid, hyaline to pale yellowish, straight or slightly curved, one to four celled, irregularly biseriate, (21)–25–35–(40) × (10)–12–14–(16) μ; paraphyses hyaline, filiform, septate, simple or branched, 1.5–2.0 μ in diameter, the tips swollen up to 5 μ and forming a slight, yellowish epithecium.

Conidial fruiting bodies minute, very inconspicuous, developing beneath the outer bark layers and raising and splitting them, forming small blister-like elevations, but not breaking through, circular

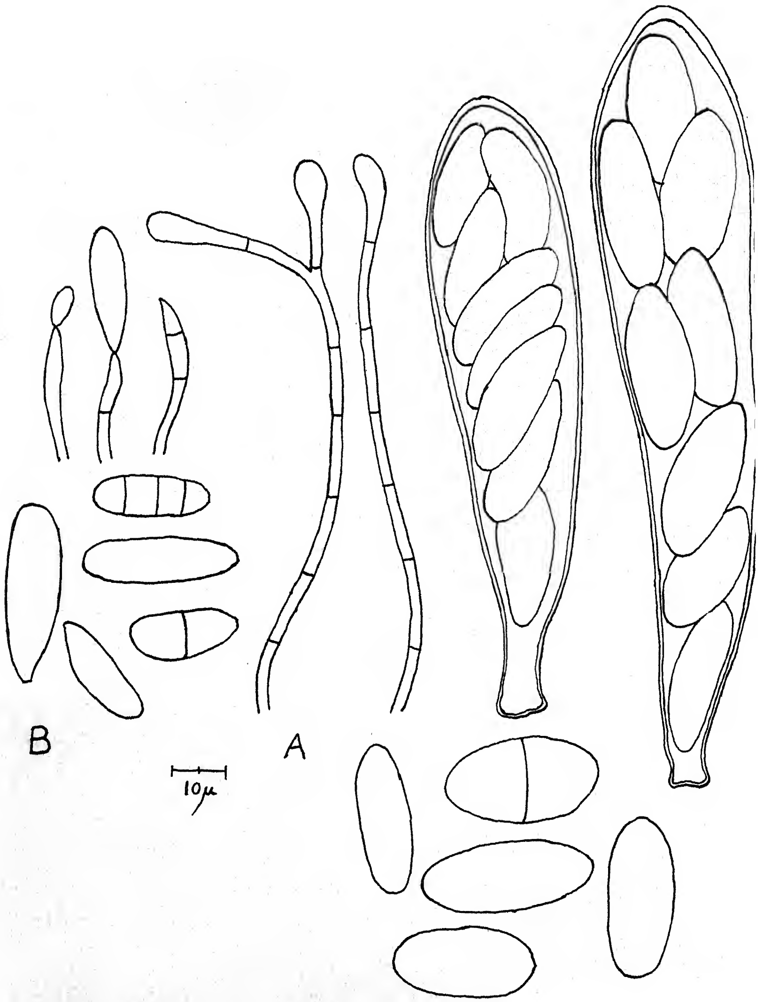


FIG. 2. *Pezicula subcarnea*. *A*, drawings of asci, ascospores, and paraphyses; *B*, conidiophores and conidia.

or slightly elongated, 250–450 μ in diameter, consisting of a pseudoparenchymatous basal stroma, composed of hyaline, irregular cells 4–7 μ in diameter, forming a layer 10–30 μ in thickness, sometimes thicker at the centre, conidiophores arising from the surface of this

layer, hyaline, cylindric, continuous or septate, simple, occasionally branched, pointed, 15–35 × 3–4 μ, sometimes swollen below the tip up to 5–6 μ; conidia oblong-ellipsoid, hyaline to slightly yellowish, straight or slightly curved, one to several celled, (20)–25–35–(40) × (7)–8–11–(14) μ; no microconidia have been observed.

Host: *Acer pennsylvanicum* L.

Type: Mycological Herbarium of the Division of Botany and Plant Pathology, Science Service, Ottawa, *2594,* Kingsmere, Que. Sept. 2, 1935.

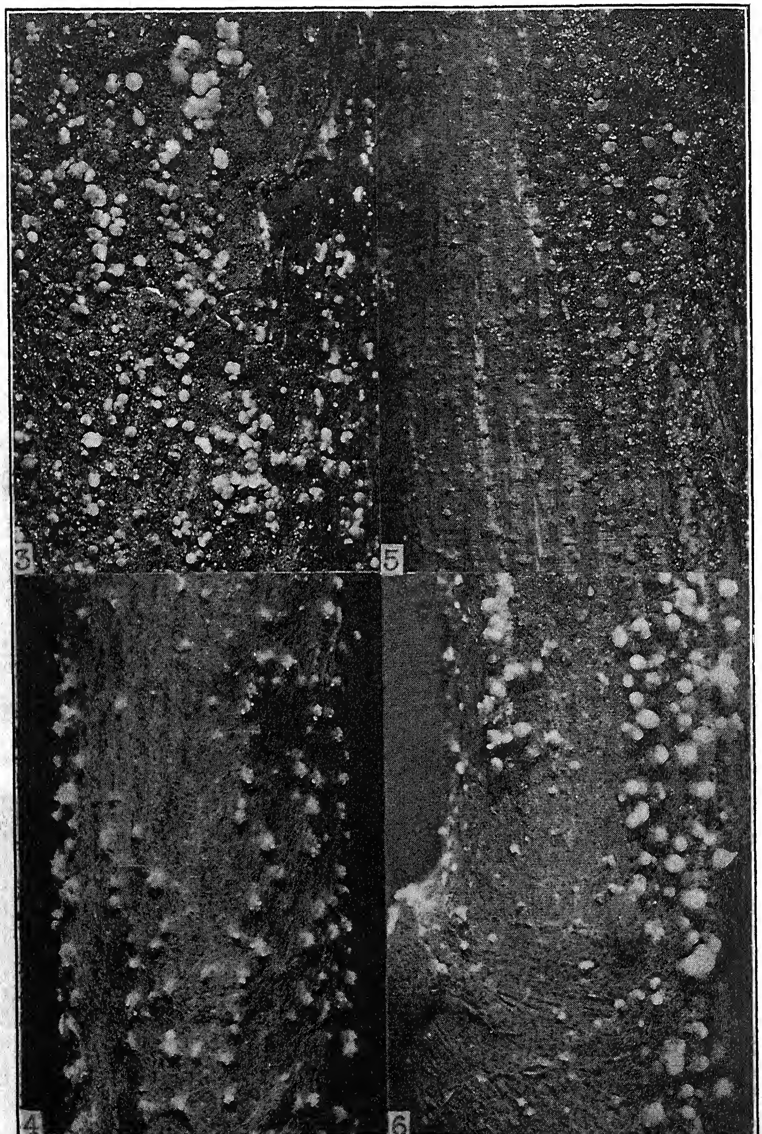
SPECIMENS EXAMINED: Mycological Herbarium of the Division of Botany and Plant Pathology, Ottawa. On *Acer pennsylvanicum. 2594* (*439*), *3992* (*132*), Kingsmere, Que.—*5728* (*662*), Temagami Forest Reserve, Ont.

University of Toronto Herbarium. On *Acer pennsylvanicum. 7269* (*146*), *7973* (*326*), *7975* (*395*), Temagami Forest Reserve, Ont.

Herbarium of J. W. Groves. On *Acer pennsylvanicum. 429,* Temagami Forest Reserve, Ont.—*701,* Millinocket, Maine, Aug. 22, 1940, comm. E. K. Cash.

On malt extract agar the colonies grow slowly, reaching a diameter of about 3 cm. in three weeks. The margin is usually appressed and almost colorless. The aerial mycelium is grayish white to buff or brownish, cottony to somewhat collapsed, often not very abundant. The conidial fruiting bodies develop as a more or less rounded to irregular, fleshy stroma, about 1–3 mm. in diameter, covered with a downy, whitish mycelium, or almost glabrous and brownish, containing one or more irregularly lobed cavities which tear open very widely. The tissue is composed of hyaline to yellowish hyphae about 3–5 μ in diameter, fairly loosely interwoven at the base but forming a compact tissue above. The conidiophores and conidia are typical and no microconidia have been observed.

On twigs of *Acer,* little aerial mycelium is produced except for a tuft of whitish to brownish, more or less collapsed mycelium at the point of inoculation. The conidial fruiting bodies are sometimes immersed as in nature, sometimes more strongly erumpent, mostly about 0.2–0.4 mm. in diameter, sometimes up to 1 mm., sparsely covered with a thin, downy, aerial mycelium. The basal stroma is variable, sometimes very thin, about 10 μ in diameter,



FIGS. 3–6. 3, Apothecia of *Pezicula carnea;* 4, conidial stage of *P. carnea* on a twig of *Acer* in culture; 5, apothecia of *P. subcarnea;* 6, conidial stage of *P. subcarnea* on a twig of *Acer* in culture. All × 4 approx.

and composed of more or less longitudinally arranged hyphae from which the conidiophores arise, sometimes much thicker and pseudoparenchymatous, composed of thick walled, hyaline cells, 5–10 μ in diameter, forming a compact tissue around the cavity but looser toward the outside. The conidiophores and conidia are typical.

This species is distinguished from *P. carnea* chiefly by the size of the asci and ascospores. In *P. carnea* the asci are mostly 15–18 μ in diameter, rarely reaching 20 μ, while in *P. subcarnea* they are mostly 24–28 μ in diameter and only occasionally as narrow as 20 μ. They are much broader in proportion to their length in the latter, and so are a different shape. The ascospores of *P. carnea* are mostly 7–9 μ in diameter, while in *P. subcarnea* they are mostly 12–14 μ in diameter. The apothecia of *P. subcarnea* are usually a little smaller and have more orange in their colouration than those of *P. carnea.* Microconidia are abundant in cultures of *P. carnea* but have not been observed in cultures of *P. subcarnea. P. acericola* is intermediate with respect to ascus width but can be easily recognised by the larger, brighter yellow, more caespitose and more strongly erumpent apothecia.

It is, therefore, concluded that at least three species of *Pezicula* may be found on species of *Acer*. *P. acericola* occurs most commonly on *A. spicatum* and *P. carnea* most commonly on *A. rubrum,* while *P. subcarnea* has been collected only on *A. pennsylvanicum.* The conidial stage of each is a typical *Cryptosporiopsis.*

CENTRAL EXPERIMENTAL FARM,
OTTAWA, ONT.

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A NEW CERCOSPORA ON LEUCOTHÖE [1]

B. H. Davis [2]

(WITH 1 FIGURE)

The species of *Cercospora* described herein has been collected frequently on *Leucothöe Catesbaei* Gray in nurseries and ornamental plantings in New Jersey and has also been found on Long Island by H. H. Whetzel. An examination of either type or cotype specimens of Cercosporae described on Ericaceous plants shows this to be specifically distinct. The more important differences follow. The *Cercospora* on *Leucothöe* differs from *C. gay-lussaci* Speg. and *C. Kalmiae* Ellis & Ev. in its narrower conidia; from *C. Oxydendri* Tracy & Earle, *C. Kalmiae, C. sparsa* Cooke and *C. Gaultheriae* Ellis & Ev. in its subhyaline to pale olivaceous conidia; and from the last two and from *C. Handelii* Bubák in its conidia with long obconically truncate bases. Its very pale olivaceous conidiophores with almost hyaline tips distinguish it from *C. Epigaeae* Ellis & Dearness, *C. molleriana* Winter, and *C. Oxydendri*. Also its conidiophores are narrower than those of *C. Gaultheriae* and shorter than those of *C. molleriana*. The following name is proposed:

Cercospora Leucothoes sp. nov. (FIG. 1).

Maculae orbiculares vel interdum irregulares, aliquando restrictae foliorum venis, aliae definitores maculae cum angusta atra elevata margine, 4–12 mm. diametro, brunneae vel griseo-brunneae, vel sordide griseae in superiore superficie, minus definitae et paene ferrugineae in inferiore superficie; fungus amphigenus sed copiosior in superiore superficie; stromatis atris, globosis vel elongatis, 40–130 μ in longitudinem; fasciculis in superiore superficie con-

[1] Journal Series paper of the N. J. Agricultural Experiment Station, Rutgers University, department of plant pathology.

[2] The writer wishes to express his appreciation of the generous help of Dr. Charles Chupp in describing the species and in making available type specimens for examination.

fertis vel confertissimis, cum 2–12 conidiophoris in inferiore superficie; conidiophoris dilutissime olivaceis cum paene hyalinis apicibus, mediocriter uniformibus in latitudinem, longioribus conidiophoris flexuosis vel raro semel geniculatis, raro septatis, non-ramosis, cicatricibus sporarum non manifestis, apicibus rotundatis, 1.5–3 × 10–35 μ; condiis subhyalinis vel dilutissime olivaceis, cylindro-obclavatis (interdum distincte cylindricis vel conspicuiter obclavatis), ad bases longe obconico-truncatis, apicibus subacutis, directis vel curvatis, septis non-conspicuis, 1.5–3 × 20–90 μ, raro 120 μ, plerumque 40–75 μ.

Hab, in foliis et caulibus *Leucothöe Catesbaei* Gray, New Brunswick, N. J.

Leaf spots circular or sometimes irregular, occasionally bounded by leaf veins, some of the more definite ones with a narrow black

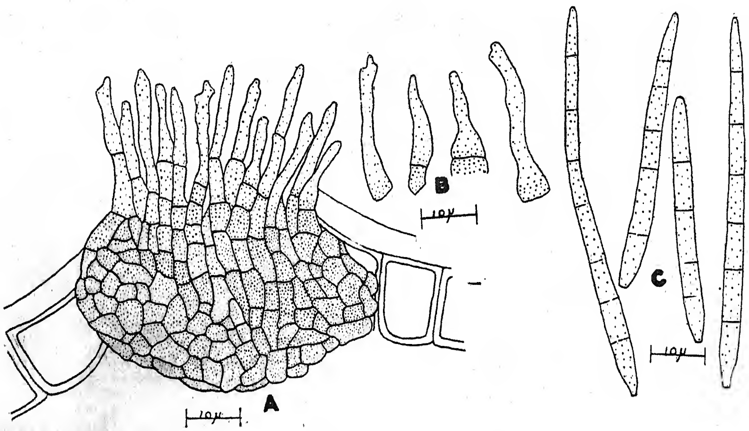

FIG. 1. *Cercospora Leucothoes.* *A,* stroma and conidiophores; *B,* conidiophores; *C,* conidia. Drawn with the aid of a camera lucida.

raised border, 4–12 mm. in diameter, brown to grayish brown or even dingy gray on upper surface, less definite and more nearly ferruginous on lower surface; fruiting structures amphigenous but more abundant on upper surface; stromata black, globular to elongate, 40–130 μ in length; fascicles on upper leaf surface dense to very dense, on lower leaf surface with 2–12 stalks; conidiophores very pale olivaceous with almost hyaline tips, fairly uniform in width, longer ones wavy or sparingly once abruptly geniculate, rarely with septa, unbranched, spore scars not evident, tips rounded, 1.5–3 × 10–35 μ; conidia subhyaline to very pale olivaceous, cylindro-obclavate (sometimes distinctly cylindric or plainly obclavate), base long obconically truncate, tips subacute, straight or curved, septa indistinct, 1.5–3 × 20–90 μ, rarely 120 μ, usually 40–75 μ.

On leaves and stems of *Leucothöe Catesbaei* Gray, New Brunswick, N. J.

Type material deposited in herbaria of Cornell University and New Jersey College of Agriculture.

N. J. Agricultural Experiment Station,
New Brunswick, N. J.

LIFE CYCLE OF PIGGOTIA FRAXINI, CAUSING LEAF DISEASE OF ASH

Frederick A. Wolf and Ross W. Davidson [1]

(with 2 figures)

A fungus commonly identified as *Piggotia Fraxini* Berk. & Curt. is among those most commonly and most widely found on the foliage of ashes throughout the United States. It appears appropriate herein to designate it *Piggotia* leaf disease of ash, since this stage of the causal fungus is most prominent and is best known to collectors. This disease is especially prevalent in nurseries and on small trees in the forest, but occurs also on large forest and shade trees. All of the more common species of ash are subject to attack, including white ash, *Fraxinus americana* L. (identical with *F. acuminata* Lam. and *F. lanceolata* Borkh. in some of the older collections); green ash, *F. pennsylvanica* Marsh. var. *lanceolata* (Borkh.) Sarg. (identical with *F. viridis* Michx.); Oregon ash, *F. oregona* Nutt.; and black ash, *F. nigra* Marsh. (identical with *F. sambucifolia* Lam.).

During the past few years our contacts with those interested in forest-tree nursery diseases and our examination of collections in herbaria show that this leaf disease occurs in Alabama, Georgia, Indiana, Illinois, Iowa, Kentucky, Louisiana, Massachusetts, Minnesota, Mississippi, Missouri, Nebraska, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, South Dakota, Tennessee, Washington, Wisconsin, and Virginia. Furthermore, a consideration of pertinent mycological studies shows that the taxonomy of the pathogen is in a confused

[1] Grateful acknowledgment is made of the use of the following herbaria: Farlow Herbarium, Harvard University; Herbarium of the New York Botanical Garden; and Mycological Collections of the Bureau of Plant Industry, U. S. Department of Agriculture. We also wish to acknowledge the assistance of W. C. Davis, Dennis H. Latham, L. R. Roof, Ernest Wright, George Y. Young, Carl Hartley, and Bailey Sleeth in collecting specimens of ash diseases occurring in forest-tree nurseries.

state because it is polymorphic and no one has traced its developmental history. The present report, therefore, recounts our efforts to clarify these taxonomic matters as revealed by the sequential appearance of the several developmental stages of the *Piggotia* leaf disease fungus. The developmental cycle has been found to include a conidial stage, by means of which the pathogen is distributed during summer, a spermogonial and a carpogonial stage, the precursors of the perithecial stage, that appear coincidentally throughout the entire period from midsummer to early winter, and finally the perithecial stage, by means of which the organism hibernates. The perithecial stage matures in spring and is believed to constitute the primary inoculum for the conidial stage.

SOURCES OF MATERIAL

As has been indicated, trees of all ages are subject to this disease although it is especially severe upon young trees. An adequate description of its appearance, although highly desirable, has a limited usefulness, since it is unusual to find this leaf disease occurring alone. Instead, it is commonly associated with several other diseases whose causal agencies have not been given detailed study. Among the pathogens quite commonly found on leaves showing this *Piggotia* disease are the spermogonial stage, *Phyllosticta viridis* Ellis & Kellerm., of *Mycosphaerella fraxinicola* (Schw.) House, whose life history was recently studied (10); *Cylindrosporium Fraxini* (Ellis & Kellerm.) Ellis & Ev. (apparently synonymous with *Cercosporella Fraxini* Ellis & Kellerm., and with *Cercospora Fraxini* Ellis & Kellerm.); *Cylindrosporium viridis* Ellis & Ev.; *Septogloeum Fraxini* Hark. (apparently synonymous with *Gloeosporium Fraxini* (Hark.) Ellis & Ev.); and *Gloeosporium punctiforme* Ellis & Ev. Data showing the frequency of occurrence of some of these fungi in forest-tree nurseries are given in table 1.

The *Piggotia* stage was present on most of the leaves containing *Marssonia Fraxini* and on all of those containing *Gloeosporium punctiforme,* but in several instances the conidia of these two fungi were also present in the same collection of leaves, so it was not definitely determined whether *G. punctiforme* has a *Piggotia* stage

similar to *P. Fraxini*. Specimens of diseased leaves containing *Gloeosporium punctiforme* could, however, not be distinguished from those containing *Marssonia Fraxini* except by microscopic examination. This fact indicates that it too may be important as a cause of defoliation. *Cylindrosporium Fraxini*, *Cercospora* sp., and *Cylindrosporium viridis* each produce conspicuous, distinctive leaf spots.

This admixture of pathogens, oftentimes with three or four of them upon one and the same leaflet, has made it difficult to determine the symptom complex of each and to secure evidence of

TABLE 1

FUNGI ON ASH LEAVES COLLECTED IN NURSERIES, 1938 TO 1940

Fungus [1]	Number of specimens [2]	Distribution: Number of states	Distribution: Number of localities	Percentage of classified specimens
Marssonia Fraxini	49	12	23	75.3
Cylindrosporium Fraxini	5	3	4	7.7
Cercospora sp.	5	3	4	7.7
Gloeosporium punctiforme	3	2	3	4.6
Cylindrosporium viridis	3	2	2	4.6
Totals	65			100.0

[1] Where several fungi were present in a collection they were recorded as separate specimens.

[2] A few specimens could not be identified because they lacked conidia.

genetic connections. These matters remained confused for several years but during the past year several clumps of small trees parasitized only by the organism under consideration were found. It has, therefore, been possible to make repeated observations throughout the year on these clumps of diseased trees, supplementing these observations by collections of specimens for immediate microscopic examination and for use in preparing paraffin sections.

APPEARANCE OF THE DISEASE AND STRUCTURE OF THE PATHOGEN

Conidial stage. Lesions bearing the conidial stage become evident about the middle of June, and conidia may continue to be formed until mid-September. Small yellowish-green indefinite spots on the upper leaf surface are the first evidence of disease.

Hundreds of flecks, none of which exceed 3 mm. in diameter, may occur on a single leaflet, in which case the entire leaflet is conspicuously yellow. Little discoloration is evident on the lower leaf surface but, with the aid of a hand lens, scattered, elevated structures are visible thereon. In moist weather these structures are pale flesh-colored, glistening, and protrude prominently, and in dry weather they are white and collapsed. By the use of paraffin sections they are seen to be acervuli, deeply seated in the spongy parenchyma (FIG. 1, *D*). The protrusions, that may extend 100 or more microns above the leaf surface, are composed of the conidial mass held together in a mucilaginous matrix. The acervular stroma may be so deeply embedded as to be hemispheric, and is composed of several layers of pale-brown, thin-walled cells (FIG. 1, *C*). The conidia are cylindrical, straight or slightly curved, obtuse-tipped, 1-septate, hyaline, and range in size from 17–40 (most commonly 24–28) $\times$ 3–4 μ (FIG. 1, *B*). These structural features are clearly those of the form genus *Marssonia*. In fact, when compared with exsiccati, the fungus is specifically identical with *Marssonia Fraxini* Ellis & Davis (1). This species was first collected in Vilas County, Wisconsin, by Dr. J. J. Davis, on the foliage of *Fraxinus nigra* (*F. sambucifolia*), and was described by him in 1903 and discussed in a later note (2).

Spermogonial and carpogonial stages. Within two or three weeks after conidia are first shed, numerous dark-brown to black structures have been formed interspersed among the acervuli. These structures soon become thickly dispersed over the entire lower leaf surface, and constitute the most conspicuous feature of the disease (FIG. 2, *A*). These structures continue to form and to mature not only while the leaves are still attached but long after the leaves have fallen. They have been collected over the entire period from early July to December.

Vertical sections of diseased leaves show that these dark structures are always deeply immersed within the leaf tissues, extending to the palisade parenchyma. Each structure is a stroma 100–200 μ in diameter, that contains one or more locules. These locules are of two types, spermagonial and carpogonial, both of which may be initiated within the same stroma and may develop coincidentally. The peripheral layer of the stromata is composed of thick-walled

cells, devoid of stainable content, and the medullary portion consists of loosely arranged, deeply staining, thin-walled cells. In the case of spermogonia, these medullary cells are the spermatium-mother cells, and in the carpogonia, the nurse tissue for the development of the asci.

Spermatial formation begins immediately beneath the ostiolar area and proceeds radially and basipetally. Details of the process are unknown except that the spermatia are abstricted as buds (FIG. 1, *E*) from the mother cells, after which the mother-cell walls disintegrate to form a mucilaginous matrix in which the spermatia are embedded. If moisture is present, the spermatia are exuded from the ostiolar orifice and adhere in a droplet or film. The spermatia are short-cylindric, hyaline cells 2–3 $\times$ 1 μ. Mature spermogonia seem multilocular, an appearance produced no doubt because the formation of spermatia does not proceed at the same rate, chains of spermatiferous cells remaining, as was described in the case of *Mycosphaerella fraxinicola* (**10**).

Comparison of this spermogonial stage with the type *Piggotia Fraxini* Berk. & Curt., collected in Pennsylvania by Michner, shows them to be identical. Specimens in herbaria show that various American mycologists have collected and identified this stage as *Piggotia Fraxini*. Collections sent to Europe have been given other names. Von Höhnel (**9**) called it *Dothichiza* (*Dothiopsis*), one of the Excipulaceae. Specimens on leaves of *Fraxinus oregona,* collected September 28, 1919, and sent to Sydow and Petrak (**8**), led them to conclude in 1922 that the organism might be made a new generic type. The following year Petrak (**7**) assigned it to *Asterostromella Fraxini* (Berk. & Curt.) Petrak, one of the Leptostromataceae. He pointed out, however, that it differed from *Asterostromella* only in the rather well developed, more or less dark-colored, pycnidial wall.

The carpogonial locules can be distinguished from spermogonia by the presence in each one of several deeply staining ascogonia that intertwine among the loosely arranged medullary cells (FIG. 1, *A*). Each ascogone is a septate filament whose trichogynal portion extends to the exterior. Presumably the spermatia lodge on these exposed trichogynes, through the agency of water, and the further

development of the carpogonia is contingent upon fertilization by the spermatia. Proof of fertilization is lacking, however.

Perithecial stage. Transformation of the carpogonial locules into perithecia takes place during winter while the decaying leaves are lying on the ground. As the fascicle of asci is forming, the deeply staining cells gradually disappear, indicating that they constitute the reserve food for the developing asci. In North Carolina some of the asci will have matured about the middle of March while the ascospores in others will not yet have been developed. Paraphyses are lacking. The asci adhere in fascicles as may be noted if perithecia are crushed in a drop of water under the cover glass. Mature asci are cylindrically saccate and measure 50–60 $\times$ 8–10 μ (FIG. 1, *F*). Each ascus contains eight biseriately arranged, hyaline, 2-celled ascospores. The upper cell is somewhat the larger.

COMPARISON WITH DESCRIBED SPECIES OF MYCOSPHAERELLA

These structural features show that the pathogen properly belongs in the genus *Mycosphaerella* (*Sphaerella*). In an effort to establish its specific identity, comparison was made first of all with the descriptions of species that have been recorded to occur on the foliage of ashes. The important comparative features of these species that should be considered are contained in table 2. From these descriptions it may be noted that the organism involved in our studies most nearly resembles *M. effigurata.*

In further efforts to identify this *Mycosphaerella* our collections have been compared with exsiccati. Such comparisons show that *S. maculiformis* and *S. punctiformis* are clearly distinct from our material. These two species occur on the foliage of various hardwoods, including *Quercus, Castanea, Acer, Platanus, Fagus, Hicoria, Tilia, Carpinus,* etc., both in Europe and in North America, for which reason they are undoubtedly different from the specialized pathogen involved in the present studies.

Sphaerella Fraxini (collected on *F. excelsior* L. in Hungary in 1883 by Linhart (presumably type specimens from Rehm's Ascomyceten No. *738*)) has much more densely aggregated perithecia and its ascospores are very much larger than those of our fungus. Furthermore, it is not known to occur on this continent.

In the type specimens of *Sphaerella fraxinea* the perithecia appear to be interspersed with those of *Mycosphaerella effigurata*. Some mycologists regard these species as identical. Ellis and Everhart (6, p. 268) state, "Specimens of *S. fraxinea* Pk. in our Herb. certainly agree well with Schweinitz' description of his *S. effigurata*." *S. fraxinea*, however, has ascospores that may readily be distinguished from *M. effigurata* since the lower cell of the former species is only one-fourth to one-third the size of the upper, while those of the latter are only slightly unequal. Collections of decaying ash leaves from the Duke Forest show ascospores like those described for *S. fraxinea*, and on these same leaflets perithecia were found that agree with those of *M. fraxinicola* and of *M. effigurata*. These three species appear to be confined to this continent.

TABLE 2

COMPARISON OF SPECIES OF *Mycosphaerella* OCCURRING ON LEAVES OF *Fraxinus* SPP.

Species	Distribution of perithecia	Dimensions of asci (μ)	Dimensions of ascospores (μ)
Mycosphaerella fraxinicola (Schw.) House	Hypophyllous, in spots	40–50×10–12	8–10×4–5
Mycosphaerella effigurata (Schw.) House	Hypophyllous, occupying entire leaf surface		15×4
Sphaerella fraxinea Peck	Amphigenous, in spots	30–40	10–12×4–5, upper cell 3–4 times the larger
Sphaerella maculiformis (Pers.) Awd.	Hypophyllous, in spots	50–60×7–8	14×3–4
Sphaerella punctiformis (Pers.) Rab.	Hypophyllous	28–45×7–9	6–9×2.5–3.0
Sphaerella Fraxini Niessl.	Hypophyllous, densely aggregated in groups	50–70×10–13	26–28×4
Sphaerella quadrangulata (Ellis & Ev.)	Epiphyllous, in white spots	60×12	16×4
Fungus under con-consideration	Hypophyllous, dispersed over entire lower leaf surface	50–60×8–10	15–18×4.5–6.0

Sphaerella quadrangulata, collected on *F. quadrangulata* Michx., is clearly distinct from the other species occurring on ash. This organism was first named *S. Sapindi* Ellis & Ev. because the host was erroneously identified as a species of *Sapindus*.

The organism under consideration is so widely prevalent in North Carolina in the area where Schweinitz collected for a period of years that it seems improbable that it could have escaped his notice. Schweinitz collected here both *M. fraxinicola* (*Sphaeria fraxinicola*) and *M. effigurata* (*S. effigurata*). These are distinct species although both may occur together on the same leaflet, as has been indicated. These facts incline us to the opinion that the organism under consideration is *M. effigurata*, although the admixture of perithecia of these two species and of those of *S. fraxinea* in exsiccati is a source of confusion which renders it impossible for anyone to be certain. Nevertheless it seems best to reëstablish the name *M. effigurata* rather than to create a new specific name.

Since this study for the first time clarifies the developmental cycle of the organism causing the *Piggotia Fraxini* leaf disease of ash, the name can best be reëstablished and taxonomic matters can be oriented by a brief descriptive summary as follows:

MYCOSPHAERELLA EFFIGURATA (Schw.) House, Emend, An index to the New York species of *Mycosphaerella*. N. Y. State Mus. Bull. 233–234, pp. 25–31. Albany, N. Y. 1921.

Syn: *Sphaeria effigurata* Schw., Syn. N. Am. Fungi No. *1790*.

Sphaerella effigurata (Schw.) Cooke, Jour. Bot. **21**: 107. 1883.

Piggotia Fraxini Berk. & Curt., N. Am. Fungi No. *433*.

Marssonia Fraxini Ellis & Davis, Trans. Wis. Acad. **14**: 97. 1903.

Septoria Besseyi Peck, Bull. Torrey Club **6**: 77. 1875.

Dothichiza ——— Höhnel, Sitz.-ber. Akad. Wien. **119**: 631. 1910. (Frag. Myk. No. *537*. 1910.)

Asterostromella Fraxini (Berk. & Curt.) Petrak, Ann. Myc. **23**: 268–269. 1923.

Peritheciis innumerosis, dispersis, saepe totum foliorum in pagina adversa occupantibus, discretis vel congestis, subinnatis, erumpentibus, nigris, sphaericis, 75–100 μ diam.; ascis fasciculatis, cylindricei-sacciformibus, aparaphysatis, 50–60 $\times$ 8–10 μ; sporidiis biserialis inordinatis, ellipticis, inaequaliter uniseptatis, loculo supero crassiore, vix constrictis, hyalinis, 15–18 $\times$ 4.5–6 μ.

Hab. in verno in pagina adversa foliorum dejectorum Fraxini spp., frequens.

Statum spermogonicum Piggotia fraxini B. et C. sistit. Spermogoniis et carpongoniis in aestivo atque autumno efformantibus, hypophyllis, innatis, in

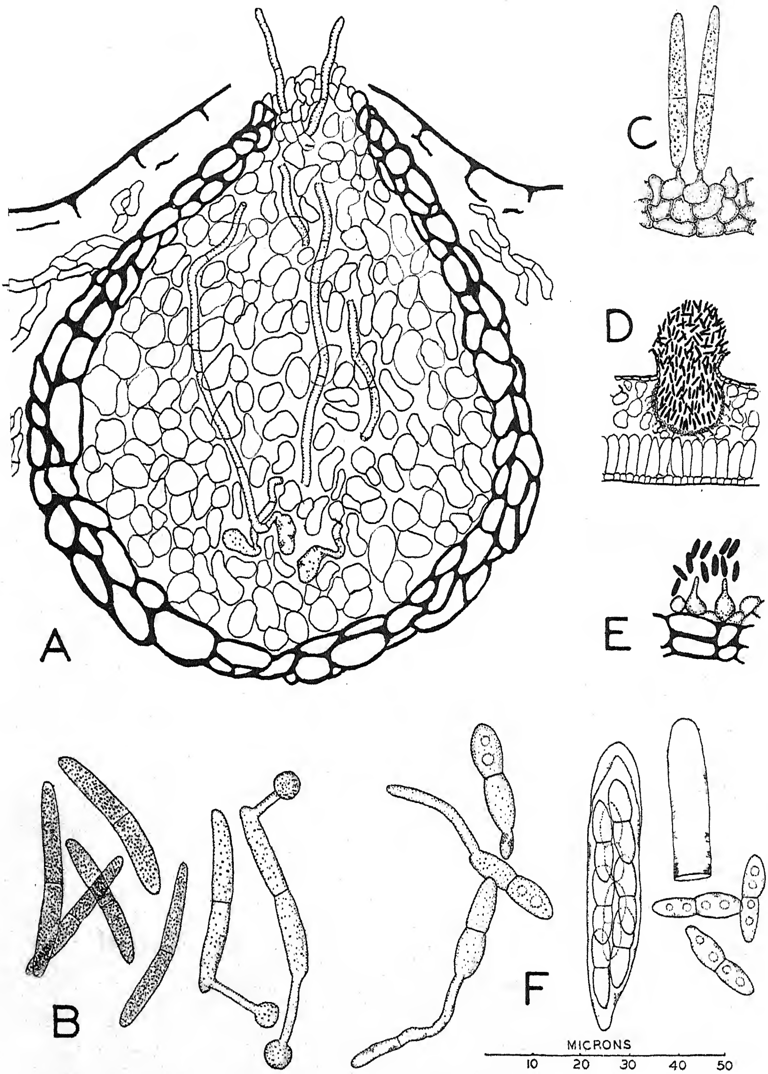

FIG. 1. All figures except *D* drawn to the same scale. *Mycosphaerella effigurata* (Schw.) House. *A,* median section of carpogonium with three ascogonial coils; *B,* conidia (*Marssonia Fraxini*), two germinated and showing appressoria; *C,* portion of acervulal wall with conidia; *D,* sketch of acervulus; *E,* spermatia and section of spermogonial wall; *F,* an ascus, germinating ascospores, ascospores, and thimble-like outer ascus membrane.

loculis stromaticis oriundis, solitariis vel congestis, punctiformibus, globosis, nigris, ca. 100 μ diam.; spermatiis bacillaribus, hyalinis, 2–3 $\times$ 1 μ.

Status conidicus: *Marssonia Fraxini* Ell. et Davis statum conidicum sistit. Maculis pallidis, minutis, indefinitis, innumerosis; acervulis innatis dein erumpentibus, in toto pagina inferiore foliorum sparsis; cirris pallide carneis; conidiis tereti-fusoideis, uniseptatis, rectisculis, hyalinis, 17–40 (saepius 24–28) $\times$ 3–4 μ.

Hab. in aestivo in foliis vivis Fraxini spp.

For the convenience of mycologists, specimens of the conidial, spermogonial and carpogonial, and ascigerous stages have been deposited in the Farlow Herbarium, Harvard University; in the herbarium of the New York Botanical Garden; and in the Mycological Collections of the Bureau of Plant Industry, U. S. Department of Agriculture.

COMPARISON OF PURE CULTURES

Comparative cultural studies were made not only of *M. effigurata* but of the associated species as follows:

(*a*) MYCOSPHAERELLA EFFIGURATA

F. P. *72189*. On *Fraxinus americana* from Washington, Ind., Sept. 1938, overwintered at Arlington, Va. Isolation from ascospores Mar. 10, 1939.

F. P. *72190*. On *Fraxinus americana* from Chapel Hill, N. C., Mar. 25, 1939. Isolation from ascospores Mar. 30, 1939.

F. P. *86489*. On *Fraxinus pennsylvanica* var. *lanceolata* from Mandan, N. Dak., Sept. 20, 1939, overwintered at Arlington, Va. Isolation from ascospores May 5, 1940.

F. P. *72181*. On *Fraxinus americana* from Charlottesville, Va., Sept. 7, 1938. Isolation from conidia Nov. 22, 1938.

F. P. *72182*. On *Fraxinus pennsylvanica* var. *lanceolata* from Clinton, Tenn., Sept. 28, 1938. Isolation from conidia Nov. 22, 1938.

F. P. *94039*. On *Fraxinus* sp. from Chapel Hill, N. C., July 19, 1940. Isolation from conidia Aug. 8, 1940.

(*b*) CYLINDROSPORIUM VIRIDIS

F. P. *72180*. On *Fraxinus pennsylvanica* var. *lanceolata* Clinton, Tenn., Sept. 27, 1938. Isolation from conidia Nov. 22, 1938.

(*c*) GLOEOSPORIUM PUNCTIFORME

F. P. *86486*. On *Fraxinus americana* from Stroudsburg, Pa., Sept. 4, 1939. Isolation from conidia Nov. 2, 1939.

(*d*) CYLINDROSPORIUM FRAXINI

F. P. *86487*. On *Fraxinus* sp. from Livingston, Ala., Oct. 23, 1939. Isolation from conidia Nov. 2, 1939.

Ascospores and conidia of *Mycosphaerella effigurata* germinate readily on cornmeal agar at ordinary room temperature of about 25° C. but subsequent growth is very slow.

Cultures from conidia were obtained by crushing spore horns in a drop of sterile water and placing this spore suspension on the surface of cornmeal agar. The use of a thin layer of agar facilitated observing germination and growth of the conidia when the dishes were inverted under a 4 mm. microscope lens.

Ascospore cultures were obtained by placing wet portions of overwintered leaves so that the ascospores could be expelled directly onto the surface of cornmeal agar. Germination and growth were then observed under the microscope in the same way as with conidia. Germinating ascospores were also studied under high magnification by removing the lids of the Petri dishes and focusing directly onto the surface of the agar. Unless germinating conidia and ascospores are allowed to develop undisturbed for a week or more before transfer to tubes of malt agar, they usually fail to grow.

The appearance and development of cultures from conidia and ascospores were similar in all respects. The mycelium developing from single spores becomes readily visible macroscopically only after a period of 10 to 18 days. The mycelium is hyaline at first, soon turning brown, and finally after 1 to 2 months on 2½ per cent malt agar is black. The lateral spread on cornmeal or malt agar is only 12 to 15 mm. during a 6 to 8 weeks' period, but the mycelium piles up on the surface of the agar in a thick, black, firm mass (FIG. 2, *B*). White to light brown gelatinous outgrowths or lobes of fungus tissue may develop from the margin of the culture, but these also gradually turn dark.

Pycnidia were never observed in cultures either from conidia or from ascospores. A few conidia were obtained from these cul-

tures, but they were usually abnormal in that one cell was globose or swollen. Conidia were never found in profusion in cultures as they are when developed under natural conditions.

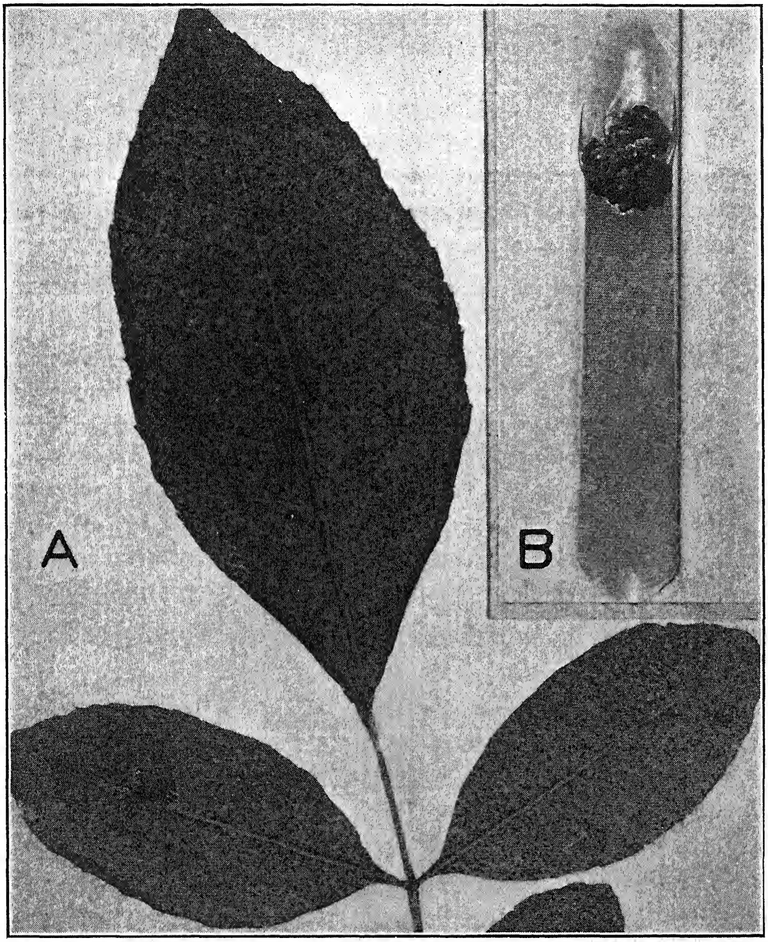

FIG. 2. *Mycosphaerella effigurata* (Schw.) House. *A*, photograph of underside of ash leaf showing the *Piggotia Fraxini* stage; *B*, culture of the fungus, two months old: grown on 2½ per cent malt agar.

The mycelial mass in cultures of *Cylindrosporium viridis* resembles somewhat that produced by *M. effigurata* but typical conidia were developed. Cultures of *Cylindrosporium Fraxini*

were distinctly different from those of *M. effigurata* but those of *Gloeosporium punctiforme* were very similar macroscopically. This latter species, however, forms 2-celled spores that are much shorter and thicker than the conidia of *M. effigurata,* and the spores are formed over the entire surface of the fungus mat.

PATHOGENICITY

All attempts in the laboratory and greenhouse to inoculate seedlings with cultures, conidia, and ascospores have failed to result in the production of the disease. It is probable that such factors as humidity, light, and temperature were not favorable. On the other hand, when old leaves bearing perithecia were attached to twigs of healthy trees in the forest, the conidial stage appeared on the young foliage after a minimal interval of 3 weeks. Infection also followed when leaves bearing conidia were attached to healthy twigs. In the case of trees with old diseased leaves beneath them on the ground, it was observed that there is a progressive upward involvement of the foliage, those nearest the ground becoming infected first in spring and then those more distant as summer advanced. These results leave little doubt of the pathogenicity of *M. effigurata,* and support the cultural studies that indicate the genetic connection of perithecial and conidial stages.

SUMMARY

The developmental cycle of a fungus commonly known as *Piggotia Fraxini* has been studied. The fungus attacks various species of ash throughout the United States and is especially common in forest-tree nurseries.

The pathogen is polymorphic, possessing a conidial stage, properly identified as *Marssonia Fraxini* Ellis & Davis, a spermogonial and carpogonial stage, commonly designated *Piggotia Fraxini* Berk. & Curt., and a perithecial stage, herein assigned to *Mycosphaerella effigurata* (Schw.) House. Evidence of a genetic connection of these stages is presented and an emended description of the fungus is included.

The pathogen is commonly associated in nature with such other species as *Mycosphaerella fraxinicola* (Schw.) House, *Sphaerella*

fraxinea Peck, *Cylindrosporium Fraxini* (Ellis & Kellerm.) Ellis & Ev., *Gloeosporium punctiforme* Ellis & Ev., and *Cylindrosporium viridis* Ellis & Ev.

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THE ASSOCIATION OF DIFFERENT ALTERATIONS IN SELF-FERTILE X-RAYED DERIVATIVES OF NEUROSPORA TETRASPERMA

Walter Scott Malloch

While fungi were among the first organisms in which the retarding action of X-rays and radium were noticed (cf. Dauphin, 1904 a, b; Ceresoli, (1904) 1907; Dautwitz, 1906), a detailed study of irradiation effects has been of more recent origin (cf. Nadson & Philippov, 1925; Nadson & Rochlin, 1933; Olenov, 1935; Dodge & Seaver, 1938). The stability of the induced alterations has been tested by means of subcultures (cf. Olenov, 1935) and by progeny tests (cf. Dodge & Seaver, 1938). A larger number of individuals may be tested by the first method, but the latter yields more precise information. Both of these methods have been used in this series of investigations, in addition to the statistical method of analysis to be presented in this paper.

Experiments in which ascospores of *Neurospora tetrasperma* were treated with Grenz rays and hard X-rays served to produce two populations which were suited for genetic studies. The first treatment consisted in irradiating ascospores with dosages of Grenz rays varying from 20,000 to 37,500 *r* units. These ascospores were soaked for twelve hours prior to activation for thirty minutes at a temperature of 61° C. The combination of prolonged soaking and short heat treatment promoted the maximum amount of growth in the resulting cultures. The second treatment consisted in irradiating ascospores with dosages of hard X-rays varying from 5,000 to 17,500 *r* units. These ascospores were then activated for ninety minutes at a temperature of 61° C., after having been in contact with a wet agar medium for two hours. This treatment tended to accentuate character expression and did not promote too rapid growth.

Previous reports on these experiments indicated that large numbers of variant cultures were induced by both methods of treatment

(cf. Goodspeed and Malloch, **1938**, **1940**). These alterations were very similar in number and appearance to those produced when ascospores or conidiospores were subjected to high temperatures for different intervals of time. Among the progeny of the X-rayed ascospores, conidiospore production was either normal, defective, or absent. These same cultures were classified as to whether they had normal perithecia, many defective perithecia, few defective perithecia, or with perithecia absent. The self-fertile cultures were further subdivided according to whether ascospore production was good, medium, fair or poor. Finally, the color of substratum was listed as light, medium (normal), or dark. While the present paper will consider only the self-fertile cultures, the remaining forms will be described in a subsequent publication.

A preliminary observation of these cultures indicated that the alterations which were induced by high-frequency radiation tended to be associated. For instance, cultures with reduced sclerotia development were frequently observed to have a light color in the substratum, whereas cultures with normal perithecia development had a chestnut-brown color. One purpose of this investigation is to present the raw correlation data, including the frequency distributions, produced by the Grenz ray and hard X-ray treatment of ascospores. This is one of the few instances in which quantitative data are presented to show the relationship existing between alterations induced by X-radiation of fungi. Tests for the homogeneity of the data of the two populations have been made in regard to the frequency distributions and the correlation data. A difference in the severity of the treatments may affect the percentage of alterations observed without necessarily affecting the association existing between two characters. Tests have also been devised to determine which characters show an association after irradiation and which occur at random. In subsequent publications, data will be presented to test the stability and consequently the nature of these associations. In certain instances, the treatment may be so severe as to affect two characters simultaneously, one of which is conditioned by the cytoplasm, and the other by an alteration in the chromosomes. Such an association would tend to disappear in subsequent transfers due to recovery of the cytoplasm. An association which is due to a simultaneous change in two genetic factors,

however, should exhibit a certain measure of stability. The statistical treatment of the data involves the use of the chi-square test as described by Snedecor (1938). Having explained the experimental methods employed, the observed data may be presented.

EXPERIMENTAL RESULTS

All cultures represented in this test produced perithecia and ascospores, as may be inferred from the title. The detailed analysis is presented in Tables 1 to 6. The fact that two sets of data have been combined in the same table should cause no confusion, since the two populations are distinctly labeled. The results of the tests for homogeneity between the distribution of individual characters in the two populations may be listed as follows:

Character	Test	X^2	P
Ascospore production.....	1	39.9361	<.01
Color of substratum......	1	14.7948	<.01
Conidiospore production...	2	15.6750	<.01
Perithecia development....	3	13.3919	<.01

Since the probability of occurrence is less than .01 in every case, we have reason to abandon the null hypothesis and look for some factor which may be causing a difference in the two populations. The most obvious factor would be a difference in the severity of the two treatments.

We may also test the homogeneity of the two populations in respect to the raw correlation data. The following values were obtained:

Characters	Test described in table	X^2	P
Ascospore production vs. color of substratum..............	1	58.2263	<.01
Ascospore production vs. conidiospore production...........	2	49.5841	<.01
Ascospore production vs. perithecia development.........	3	35.2311	<.01
Color of substratum vs. conidiospore production............	4	25.8609	<.01
Color of substratum vs. perithecia development.........	5	28.6691	<.01
Conidiospore production vs. perithecia development......	6	26.8479	<.01

TABLE 1

RAW CORRELATION DATA FOR COLOR OF SUBSTRATUM IN ORIGINAL TUBE AND ASCOSPORE PRODUCTION IN ORIGINAL TUBE OF SELF-FERTILE X-RAYED DERIVATIVES OF *Neurospora tetrasperma*

1	2	3	4	5	6	7
2			Color of substratum in original tube			
3	Ascospore production in original tube	Type of X-ray	Dark	Medium	Light	Totals for ascospore production
4	Good ascospore production	Hard	0	62	1	63
5		Grenz	0	124	0	124
6	Medium ascospore production	Hard	3	26	3	32
7		Grenz	32	61	2	95
8	Fair ascospore production	Hard	3	42	3	48
9		Grenz	16	29	4	49
10	Poor ascospore production	Hard	19	36	13	68
11		Grenz	22	14	6	42
12	Totals for color of substratum	Hard	25	166	20	211
13		Grenz	70	228	12	310

14	Test	Distribution	Rows combined	Columns combined	X^2	*P*
15	Homogeneity of hard X-ray and Grenz ray data	Color of substratum	4+6+8+10 5+7+9+11	None	14.7948	<.01
16		Ascospore production	None	4+5+6	39.9361	<.01
17		Correlation data	4+6, 8+10 5+7, 9+11	None	58.2263	<.01
18	Association of ascospore production and color of substratum	Hard X-ray	4+6, 8+10	None	20.3529	<.01
19		Grenz ray	5+7, 9+11	None	49.9502	<.01

Due to the fact that the probability values are less than .01 in every experiment, there is reason to suspect that the two populations are not homogeneous. It seems probable that the different X-ray and activation treatments have caused a variation in the distribution of the two populations. This difference consisted in the

TABLE 2

CORRELATION DATA FOR CONIDIOSPORE PRODUCTION AND ASCOSPORE PRODUCTION IN ORIGINAL TUBE OF SELF-FERTILE X-RAYED DERIVATIVES OF *Neurospora tetrasperma*

1	2	3	4	5	6	7
2			Conidiospore production in original tube			
3	Ascospore production in original tube	Type of X-ray	Normal	Defective	Absent	Totals for ascospore production
4	Good ascospore production	Hard	3	50	10	63
5		Grenz	29	78	17	124
6	Medium ascospore production	Hard	1	26	5	32
7		Grenz	16	56	23	95
8	Fair ascospore production	Hard	4	17	27	48
9		Grenz	4	32	13	49
10	Poor ascospore production	Hard	4	37	27	68
11		Grenz	2	19	21	42
12	Totals for conidiospore production	Hard	12	130	69	211
13		Grenz	51	185	74	310

14	Test	Distribution	Rows which were combined	Columns which were combined	X^2	P
15	Homogeneity of hard X-ray and Grenz ray data	Conidia	None	4+5	15.6750	<.01
16		Ascospore	None	4+5+6	39.9361	<.01
17		Correlation	4+6, 8+10, 5+7, 9+11	None	49.5841	<.01
18	Association of conidia and ascospore characters	Hard X-rays	4+6, 8+10	None	25.2602	<.01
19		Grenz rays	5+7, 9+11	None	17.7167	<.01

fact that the hard X-ray treatment caused a more sudden change, with a higher end point.

Since these tests indicate that the two populations are not homogeneous, it is a matter of interest to examine the association between characters in each population. For sake of emphasis, we

may repeat that in testing for association between characters, a null hypothesis is set up, but, in this case, the assumption is made that there is no association. The chi-square test of association between different characters may be listed in the following way:

Characters	Test described in table	Type of X-ray	X^2	P
Ascospore production vs.	1	Hard	20.3529	<.01
color of substratum		Grenz	49.9502	<.01
Ascospore production vs.	2	Hard	25.2602	<.01
conidiospore production		Grenz	17.7167	<.01
Ascospore production vs.	3	Hard	111.4879	<.01
parathecia development		Grenz	127.3401	<.01
Color of substratum vs.	4	Hard	10.8280	<.01
conidiospore production		Grenz	16.9173	<.01
Color of substratum vs.	5	Hard	22.2020	<.01
perithecia development		Grenz	74.3275	<.01
Conidiospore production vs.	6	Hard	22.4909	<.01
perithecia development		Grenz	18.5367	<.01

In considering these results, it may be noted that an association appears to exist between every pair of characters under consideration. This means that normal perithecia development is associated with normal conidiospore production, normal ascospore production, and normal color of substratum. Likewise, normal conidiospore production is associated with normal ascospore production and normal color of substratum.

Finally, it may be noted that the original data indicate that this association is by no means complete; for instance, cultures which failed to produce conidia may exhibit normal ascospore production, and cultures with a dark substratum may produce a normal amount of conidiospore growth.

Data presented in this article have demonstrated the manner in which X-rayed alterations are induced, but an important part of the investigation was to determine the hereditary nature of the new types. In order to obtain this information, a number of progenies were grown from spore prints. This procedure can be used to determine whether or not alterations are transmitted to the next generation, but it does not indicate the ratio in which they are inherited. The method is illustrated by the data presented in Table 7. Experiment G2414 represents cultures derived from original X-rayed ascospores of *N. tetrasperma.* Tube 37 (G2414

TABLE 3

RAW CORRELATION DATA FOR PERITHECIA DEVELOPMENT AND ASCOSPORE PRODUCTION IN ORIGINAL TUBES OF SELF-FERTILE X-RAYED DERIVATIVES OF *Neurospora tetrasperma*

1	2	3	4	5	6	7
2			Perithecia development in original tube			
3	Ascospore production in original tube	Type of X-ray	Normal perithecia	Many defective perithecia	Few defective perithecia	Totals for ascospore production
4	Good ascospore production	Hard	59	4	0	63
5		Grenz	124	0	0	124
6	Medium ascospore production	Hard	0	32	0	32
7		Grenz	0	95	0	95
8	Fair ascospore production	Hard	0	46	2	48
9		Grenz	0	40	9	49
10	Poor ascospore production	Hard	0	32	36	68
11		Grenz	0	23	19	42
12	Totals for perithecia development	Hard	59	114	38	211
13		Grenz	124	158	28	310

14	Test	Distribution	Rows combined	Columns combined	X^2	P
15	Homogeneity of hard X-ray and Grenz ray data	Production of perithecia	4+6+8+10 5+7+9+11	None	13.3919	<.01
16		Ascospore production	None	4+5+6	39.9361	<.01
17		Correlation data	4+6, 8+10 5+7, 9+11	None	35.2311	<.01
18	Association between ascospore production and development of perithecia	Hard	4+6, 8+10	None	111.4879	<.01
19		Grenz	5+7, 9+11	None	127.3401	<.01

T37) and Tube 39 (G2414 T39) of this population were characterized by defective conidiospore production, defective perithecia development, and medium ascospore production. F_2 progeny raised

from these cultures exhibited 100.0 and 94.4 per cent normal conidiospore production respectively. In these two populations, the total percentage of cultures with normal perithecia amounted to 97.9 and 95.5 per cent. Finally, the percentage of self-sterile cultures for the same progenies amounted to 1.1 and 4.4. Judging

TABLE 4

RAW CORRELATION DATA FOR COLOR OF SUBSTRATUM AND CONIDIOSPORE PRODUCTION IN ORIGINAL TUBES OF SELF-FERTILE X-RAYED DERIVATIVES OF *Neurospora tetrasperma*

1	2	3	4	5	6	7
2			Color of substratum in original tube			
3	Conidiospore production in original tube	Type of X-ray	Dark	Medium	Light	Totals for conidiospore production
4	Normal conidia	Hard	1	11	0	12
5		Grenz	4	46	1	51
6	Defective conidia	Hard	9	109	12	130
7		Grenz	44	138	3	185
8	Conidia absent	Hard	15	46	8	69
9		Grenz	22	44	8	74
10	Totals for color of substratum	Hard	25	166	20	211
11		Grenz	70	228	12	310

12	Test	Distribution	Rows combined	Columns combined	X^2	P
13	Homogeneity of hard X-ray and Grenz ray data	Color of substratum	4+6+8 5+7+9	None	14.7948	<.01
14		Conidiospore production	None	4+5+6	15.6750	<.01
15		Correlation data	6+8, 7+9	None	25.8609	<.01
16	Association between conidiospore production and color of substratum	Hard X-rays	6+8	None	10.8280	<.01
17		Grenz rays	7+9	None	16.9173	<.01

TABLE 5

Raw Correlation Data for Color of Substratum and Perithecia Development in Original Tubes of Self-fertile X-rayed Derivatives of *Neurospora tetrasperma*

1	2	3	4	5	6	7
2			Color of substratum in original tube			
3	Perithecia characters in original tube	Type of X-ray	Dark	Medium	Light	Totals for perithecia development
4	Normal perithecia	Hard	0	59	0	59
5		Grenz	0	124	0	124
6	Many defective perithecia	Hard	16	90	8	114
7		Grenz	66	87	5	158
8	Few defective perithecia	Hard	9	17	12	38
9		Grenz	4	17	7	28
10	Totals for color of substratum	Hard	25	166	20	211
11		Grenz	70	228	12	310

12	Test	Distribution	Rows combined	Columns combined	X^2	P
13	Homogeneity of hard X-ray and Grenz ray data	Color of substratum	4+6+8 5+7+9	None	14.7948	<.01
14		Perithecia production	None	4+5+6	13.3919	<.01
15		Correlation data	6+8, 7+9	None	28.6691	<.01
16	Association of perithecia production and color of substratum	Hard X-ray	6+8	None	22.2020	<.01
17		Grenz ray	7+9	None	74.3275	<.01

from this evidence, Tubes 37 and 39 may be considered as representing the so-called physiological type of alteration which is frequently induced by X-radiation. In other words, since recovery occurred in nearly all characters of the F_2 progeny, there was no basis for regarding such cultures as mutations.

In contrast to these results, we may consider the behavior of two additional populations. Tube 38(G2414 T38) of the original pop-

uation (G2414) was characterized by defective conidiospore production, normal perithecia development, and good ascospore production. Tube 41 (G2414 T41) showed the absence of conidiospore production, normal perithecia development, and medium ascospore production. In the F_2 progenies raised from these cultures, a certain measure of recovery occurred in conidiospore production and perithecia development, but the presence of a high percentage

TABLE 6

CORRELATION DATA FOR PERITHECIA DEVELOPMENT AND CONIDIOSPORE GROWTH IN ORIGINAL TUBES OF SELF-FERTILE X-RAYED DERIVATIVES OF *Neurospora tetrasperma*

1	2	3	4	5	6	7
2			Perithecia characters in original tube			
3	Conidia characters in original tube	Type of X-ray	Normal perithecia	Many defective perithecia	Few defective perithecia	Totals for conidia characters
4	Normal conidiospore growth	Hard	3	6	3	12
		Grenz	29	21	1	51
6	Defective conidiospore growth	Hard	50	56	24	130
7		Grenz	78	94	13	185
8	Conidia absent	Hard	6	52	11	69
9		Grenz	17	43	14	74
10	Totals for perithecia characters	Hard	59	114	38	211
11		Grenz	124	158	28	310

12	Test	Distribution	Rows combined	Columns combined	X^2	P
13	Homogeneity of hard X-ray and Grenz ray data	Conidia	None	4+5+6	15.6750	<.01
14		Perithecia	4+6+8, 5+7+9	None	13.3919	<.01
15		Correlation data	4+6, 5+7	None	26.8479	<.01
16	Association of conidia and perithecia characters	Hard X-rays	4+6	None	22.4909	<.01
17		Grenz rays	5+7	None	18.5367	<.01

TABLE 7

PROGENY TESTS OF X-RAYED DERIVATIVES OF *Neurospora tetrasperma*

Number of culture	G2414	G2414 $37F_1$	G2414 $38F_1$	G2414 $39F_1$	G2414 $40F_1$	G2414 $41F_1$	G2414 $42F_1$
Percentage of cultures showing positive growth	89.0	95.0	76.0	90.0	24.0	40.0	83.0
Percentage of cultures with normal perithecia and normal conidia	33.7	97.9	73.7	92.2	0.0	50.0	55.4
Percentage of cultures with normal perithecia and reduced conidia	14.6	0.0	1.3	3.3	0.0	25.0	0.0
Total percentage of cultures with normal perithecia	48.3	97.9	75.0	95.5	0.0	75.0	55.4
Percentage of cultures with fertile defective perithecia	10.1	1.1	1.3	0.0	4.2	0.0	8.4
Percentage of cultures with sterile perithecia	20.2	0.0	1.3	3.3	16.7	0.0	0.0
Percentage of cultures with sclerotia	18.0	1.1	17.1	1.1	25.0	20.0	36.1
Percentage of cultures without sclerotia	3.4	0.0	5.3	0.0	54.2	5.0	0.0
Percentage of cultures without perithecia	21.4	1.1	22.4	1.1	79.2	25.0	36.1
Percentage of self-sterile cultures	41.6	1.1	23.7	4.4	95.9	25.0	36.1
Percentage of cultures without conidia	12.4	0.0	7.9	0.0	45.8	7.5	0.0
Percentage of cultures with defective conidia	44.9	0.0	10.5	5.6	33.3	30.0	0.0
Percentage of cultures with normal conidia	42.7	100.0	81.6	94.4	20.8	62.5	0.0
Percentage of cultures with defective forms	66.3	2.1	26.3	7.8	100.0	50.0	44.6

of self-sterile cultures was a significant indication of induced alterations.

The analysis may be continued by the study of another culture which is of particular interest in this regard. This culture (G2414 T40) was characterized by defective conidiospore production, defective perithecia development, and medium ascospore production. Tube 40 thus showed a strong resemblance to Tube 39, but the genetic behavior was quite different. The F_2 progeny raised from Tube 40 surpassed the original population (G2414) in the percentage of alterations produced. Normal conidiospore production was reduced to 20.8 per cent, and a high percentage of self-sterile cultures was found. Tube 40, then, represents an instance in which X-radiation induced a wide variety of heritable alterations.

Tube 42 (G2414 T42) was distinguished by the absence of co-

nidiospore production, defective perithecia development, and medium ascospore production. In the F_2 progeny, the total percentage of cultures without perithecia amounted to 36.1 per cent, as compared with 21.4 per cent in the original population. In the hybrid population, the characters were so distinct that there could be no doubt as to the heritable nature of the alterations. A detailed ascus analysis of Tube 42 has been made, but it will be described in detail elsewhere.

DISCUSSION

Studies which have been made since the discovery of X-rays indicate that alterations in functional and structural characters can be induced by exposing fungi to high-frequency radiation (cf. Smith, **1936**). This investigation has extended these conclusions, in that many alterations in physiological and morphological characters were produced by subjecting ascospores of *Neurospora tetrasperma* to Grenz radiation and hard X-rays. In order to study the manner in which the alterations were induced, the activation treatment used in the Grenz-ray experiment was varied from the one used with hard X-rays, with the expectation that the alterations induced by the first treatment might show a different distribution from those produced by the second one. Conidiospore and ascospore production, perithecia development, and color of substratum were among the characters which were affected.

The statistical analysis presented in Tables 1 to 6 justified the experimental procedure adopted. A probability value of less than .01, which was obtained in every test, indicated that the frequency distributions of individual characters in the Grenz-ray and hard X-ray experiments were not homogeneous. A similar set of tests indicated that the correlation data for the two populations were not homogeneous either. In addition, the tests indicated that it would be advisable to calculate separate chi-square values in testing for the presence of an association between two characters.

Different methods of treatment were chosen in order to determine if two characters would still show an association in spite of a difference in the frequency distributions of the two populations. Probability values of less than .01 gave us reason to suspect that there was an association between the characters induced by the

original X-ray treatment. Having determined that X-ray-induced alterations tended to occur simultaneously, it was desirable to investigate the reason for this phenomenon.

The problem was approached by studying the genetic behavior of F_2 progenies. Data presented in Table 7 indicate that certain alterations were temporary in nature, while others had a genetic basis. It is to be noted that the characters of the original cultures were not transmitted as a unit but that segregation occurred. This is to be expected since the cultures were self-fertile X-rayed derivatives of *N. tetrasperma.* In order to produce a homozygous culture it would be necessary to affect both members of every allelomorphic pair under consideration. Evidence summarized by Schultz (1936) indicates that this is a very unlikely situation in higher organisms. It will be shown elsewhere that this condition has occurred in *N. tetrasperma,* but heterozygous cultures are more frequent.

The relationship existing between X-ray-induced alterations is a matter of considerable interest in that definite genetic factors are now known which affect these characters. Dodge and Seaver (1938) found that ascospore production was affected by two characters, *d* and *I*, for deliquescing and indurated ascus abortion. The present investigation has shown that a factor *p* has a marked influence on conidiospore and ascospore production, perithecia development, and color of substratum. Cultures having the genetic constitution *PP* were characterized by normal color and development, but cultures which were homozygous for the recessive factors *pp* showed pale, fluffy conidiospore growth and reduced perithecia development and ascospore production, as well as a light color in the substratum. In this case, the characters were associated because they were all conditioned by the same genetic factors.

Other factors were found which exhibit true genetic linkage. The factor *w* reduces hyphal growth and conidiospore production when in the haploid condition. The recessive factor *w* is strongly linked to the sex factor *A* which conditions pale conidiospore color. Regardless of the underlying cause, the characters which are associated are those which are present in the control and those which have been produced by X-radiation. However, the fact that it is possible to obtain every combination of two sets of characters,

such as conidiospore production and perithecia development, indicates that the X-rayed ascospores received different amounts of radiation and that different areas of the ascospores were affected. The interpretation of this data will be supported by additional evidence to be reported soon.

SUMMARY

1. In this experiment, cultures were raised from ascospores of *Neurospora tetrasperma* which had been exposed to Grenz radiation and hard X-rays.

2. The homogeneity of the frequency distributions was tested by the chi-square method. Frequency distributions for ascospore production, color of substratum, conidiospore production, and perithecia development in the Grenz radiation and hard X-ray experiments were not homogeneous.

3. In the two populations under consideration, correlation data for six different character contrasts were not homogeneous.

4. The chi-square tests indicate that good ascospore production was associated with normal perithecia development, normal color in substratum, and normal conidiospore production. Likewise, each of these characters was associated with all of the others.

5. Progeny tests demonstrated that certain induced alterations were unstable and returned to normal in the next generation, while others segregated into well-defined genetic types. In other words, the observed associations between different characters were sometimes due to genetic factors and sometimes to the fact that the treatment was sufficiently strong to affect two characters simultaneously.

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INHERITANCE OF SORUS CHARACTERS IN HYBRIDS BETWEEN USTILAGO AVENAE AND U. PERENNANS[1]

George W. Fischer and C. S. Holton[2]

(with 3 figures)

INTRODUCTION

Recently the writers (4) reported successful attempts at hybridization of *Ustilago Avenae* (Pers.) Jens. and *U. perennans* Rostrup, two morphologically indistinguishable species parasitizing cultivated oats (*Avena sativa* L.) and tall oatgrass (*Arrhenatherum elatius* (L.) Mert. & Koch.), respectively. Wild oats, *Avena fatua* L., was used as the host for the production of the F_1 chlamydospores. Seed of Anthony oats and tall oatgrass were inoculated with hybrid chlamydospores and segregates resembling the *U. Avenae* parent were obtained on the oats, but no infection was obtained on tall oatgrass and, consequently, neither the *U. perennans* parent nor a segregate resembling it was recovered on this host. Obviously, therefore, this failure to obtain infection of tall oatgrass with the hybrid chlamydospores constitutes a gap in the evidence that hybridization between these two species was demonstrated. It was observed, however, that certain segregates on Anthony oats were characteristically similar to those of *U. perennans* on tall oatgrass and this appeared to be further indication that hybridization had occurred. For this reason detailed studies were made to determine the nature of the segregates produced by the four hybrids on Anthony oats, especially with regard to sorus type.

[1] Coöperative investigations of the Divisions of Forage Crops and Diseases and Cereal Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture, with the Washington State Agricultural Experiment Station, Pullman, Wash. Published with the approval of the director as Scientific Paper No. 485.

[2] Associate Pathologist, Division of Forage Crops and Diseases, and Associate Pathologist, Division of Cereal Crops and Diseases, Bureau of Plant Industry, United States Department of Agriculture.

U. perennans is characterized by the development, on tall oatgrass, of dark-brown, powdery sori which are covered by the partially-destroyed glumes. *U. Avenae* on oats, on the other hand, typically, produces dark-brown, powdery, naked sori. However, one of the two *U. Avenae* parents involved in the four hybrids discussed in this paper is characterized by indurate, black sori. Therefore, the hybrids of *U. perennans* with this black indurate race of *U. Avenae* involve the characters powdery sori, indurate sori, naked sori, and covered sori, as well as pathogenicity. This black indurate type of sorus in *U. Avenae,* and its heritability, have been fully described by Holton (3). At the same time preliminary cross-infection experiments with the two smut species were begun. The results of these studies are presented in this paper.

MATERIALS AND METHODS

Seed of Canadian oats (C. I. 1625) and four strains of tall oatgrass were inoculated with F_1 chlamydospores of four hybrids between *Ustilago Avenae* and *U. perennans,* inbred chlamydospores of the two parent races of *U. Avenae,* and mass chlamydospores of three field collections of *U. perennans.* The pedigree of the hybrid chlamydospores is shown in Table 1. In all four hybrids *U. perennans* is represented by the same pedigreed monosporidial lines, whereas *U. Avenae* is represented by four pedigreed monosporidial lines, two from each of the powdery and indurate sorus types recently described (3).

Inoculations also were made on Canadian, Victory (C. I. 560) and Anthony (C. I. 2143) oats with F_2 chlamydospores of 12 selections from the hybrids mentioned above, and with mass chlamydospores of the three collections of *Ustilago perennans.* The hybrid selections were based on type of sorus produced by the F_2 on Canadian oats and are designated as shown in Table 2.

The inoculum was prepared and the seed was treated and inoculated in the manner previously described (3). The tall oatgrass seed was planted in the greenhouse in $3 \times 3 \times 3''$ wooden veneer bands from which the seedlings were later transplanted to the field. The oats were planted and grown to maturity in the greenhouse. Under these conditions the host populations were too small for analysis on a ratio basis of the sorus types produced.

TABLE 1

RESULTS OF INOCULATIONS OF CANADIAN OATS AND TALL OATGRASS WITH F_1 SPORES OF FOUR *Ustilago Avenae* × *U. perennans* HYBRIDS, WITH *U. Avenae* SELFED, AND WITH THREE FIELD COLLECTIONS OF *U. perennans*

Species or cross	Sporidial combination	Type of inoculum	Per cent smut on				
			Canadian oats (C.I. 1625)	Tall oatgrass			
				W. 1719	W. 755	W. 447	W. 4295
U. Avenae 54 × *U. perennans* 8	1×3	F_1 spores	92.3	0.0	0.0	0.0	0.0
U. Avenae 54 × *U. perennans* 8	4×3	F_1 spores	21.8	0.0	0.0	0.0	0.0
U. Avenae 56 × *U. perennans* 8	1×3	F_1 spores	40.9	0.0	0.0	0.0	0.0
U. Avenae 56 × *U. perennans* 8	4×3	F_1 spores	56.0	0.0	0.0	0.0	0.0
U. Avenae 54 (selfed)	1×2	F_1 spores	92.9	0.0	0.0	0.0	0.0
U. Avenae 56 (selfed)	1×2	F_1 spores	82.6	0.0	0.0	0.0	0.0
U. perennans D-A1 (field col.)	—	Spores	12.2	22.2	26.4	23.0	15.6
U. perennans D-A2 (field col.)	—	Spores	5.2	19.2	40.0	25.0	25.0
U. perennans D-A3 (field col.)	—	Spores	8.4	23.8	31.8	66.6	12.5
Check rows	—	—	0.0	0.0	0.0	0.0	0.0

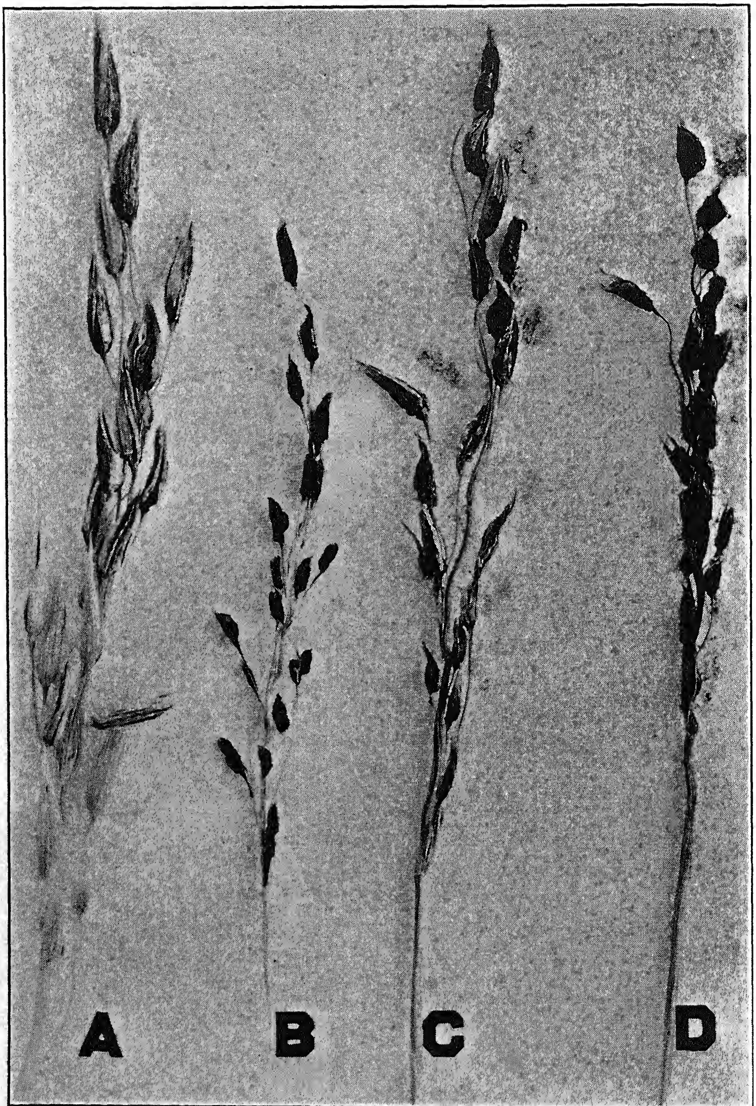

FIG. 1. Four types of F_2 segregates for sorus characters from a hybrid between *Ustilago Avenae* and *U. perennans*: *A*, covered indurate; *B*, naked indurate; *C*, covered powdery; *D*, naked powdery. On Anthony oats. Approx. nat. size.

TABLE 2

RESULTS OF INOCULATIONS OF THREE OAT VARIETIES[1] WITH *Ustilago perennans* AND WITH F_2 SEGREGATES OF FOUR HYBRIDS BETWEEN *Ustilago Avenae* AND *U. perennans*

Species or cross	Nature of inoculum			Per cent smut in F_3 on		
	Sporidial combination	Inoculum	Type of sorus in F_2	Canadian C.I. 1625	Victory C.I. 560	Anthony C.I. 2143
U. A. 56×U. p. 8	4×3[2]	F_2 spores	Covered	51.8	35.1	56.6
U. A. 56×U. p. 8	4×3	F_2 spores	Naked	28.5	9.3	27.5
U. A. 56×U. p. 8	1×3	F_2 spores	Covered	5.7	6.8	2.8
U. A. 56×U. p. 8	1×3	F_2 spores	Naked	7.6	2.7	9.0
U. A. 54×U. p. 8	1×3	F_2 spores	Powdery naked	42.3	6.8	44.1
U. A. 54×U. p. 8	1×3	F_2 spores	Indurate naked	26.6	10.0	19.3
U. A. 54×U. p. 8	1×3	F_2 spores	Powdery covered	80.0	70.5	76.4
U. A. 54×U. p. 8	1×3	F_2 spores	Indurate covered	83.3	53.5	95.4
U. A. 54×U. p. 8	4×3	F_2 spores	Powdery naked	50.0	12.1	23.5
U. A. 54×U. p. 8	4×3	F_2 spores	Indurate naked	66.6	22.2	29.7
U. A. 54×U. p. 8	4×3	F_2 spores	Powdery covered	76.9	68.4	78.2
U. A. 54×U. p. 8	4×3	F_2 spores	Indurate covered	94.2	64.2	95.4
U. perennans D-A1		Spores		40.0	28.5	58.3
U. perennans D-A2		Spores		85.7	20.0	78.5
U. perennans D-A3		Spores		12.5	37.5	33.3
Check rows				0.0	0.0	0.0

[1] No smut appeared on any of the four accessions of tall oatgrass from the hybrid inoculum.

[2] This represents the original interspecies sporidial combination that gave rise to the F_1 spores. Thus the parentage of U. A. 56 × U. p. 8, 4 × 3, is sporidium No. 4 (numbers begin at distal end of promycelium) of promycelium No. 56 of *U. Avenae* × sporidium No. 3 of promycelium No. 8 of *U. perennans*.

The separation or classification of sorus types was based on published descriptions (3) of the powdery and indurate types and their nature of inheritance, and on comparison with parent types produced on the same varieties under similar conditions.

RESULTS

F_1 and F_2 Generations

The percentages of infection produced by the F_1 generation of four hybrids between *Ustilago Avenae* and *U. perennans* were reported in a previous paper (4), but the type of smutted panicle produced was not described. In the more recent studies, however, this phase of the problem has been considered. In this connection it should be pointed out that the F_1 generation was produced on wild oats, while succeeding generations were on cultivated oats, and, consequently, the smutted panicles produced by the F_1 are not entirely comparable in character with those of the F_2 and F_3 generations. In other words, the loose smut type produced by *U. Avenae* on wild oats usually does not exhibit the naked sorus typical of this species on cultivated oats but often resembles to some extent the covered sorus type of *U. levis* (Kellerm. & Swingle) Magnus. Therefore, interpretation and classification of the type of smutted sorus produced by the F_1 on wild oats must be made in that light.

In all four hybrids the sori of the F_1 generation were classified as naked, indicating the dominance of this character of both *Ustilago Avenae* parents over the covered character of the *U. perennans* parent. In the two hybrids in which the *U. Avenae* parent was of the naked indurate sorus type, the results indicate that the powdery character of the *U. perennans* parent is dominant over the indurate character. In the other two hybrids, in which the *U. Avenae* parent was of the naked powdery sorus type, the results indicate that the naked character is dominant over the covered (*U. perennans*) character.

The results obtained from inoculations with F_1 chlamydospores are presented in Table 1. In keeping with the results previously reported (4) no infection was obtained on tall oatgrass inoculated with the four F_1 hybrids and the two selfs of *U. Avenae*, although

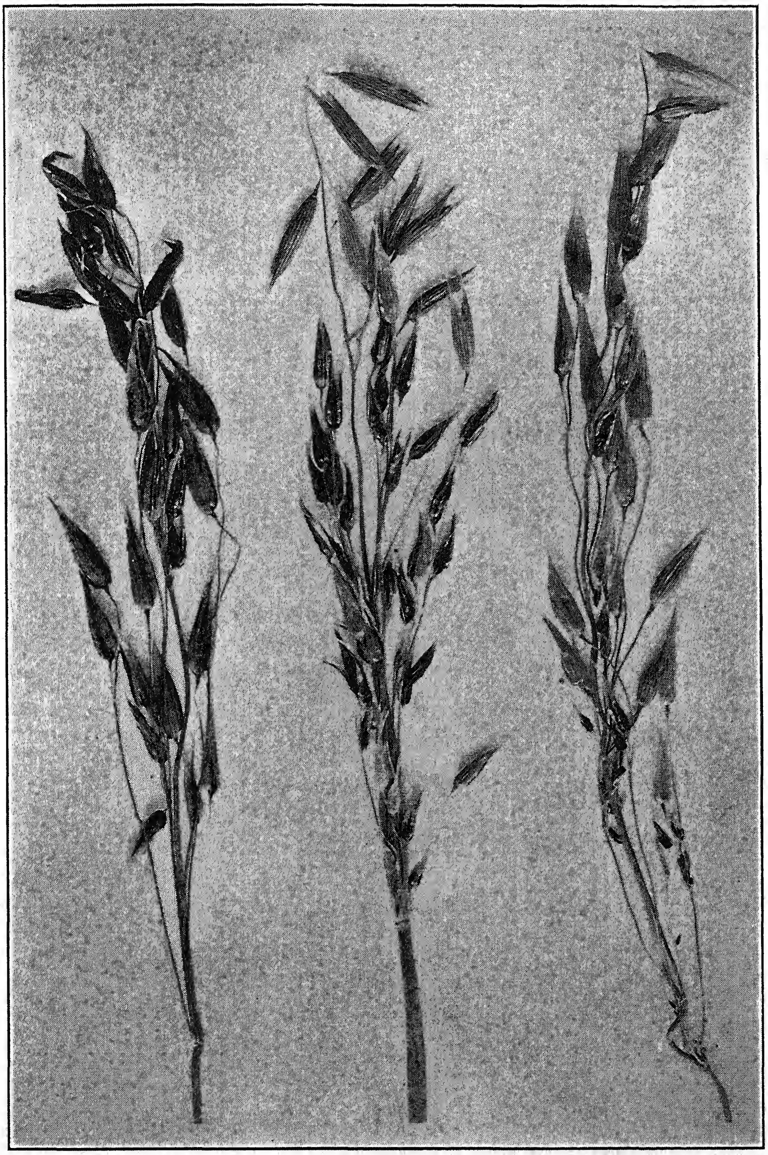

FIG. 2. *Ustilago perennans* on three varieties of cultivated oats: left to right, Anthony, Victory, and Canadian. Approx. nat. size.

the field collections of *U. perennans* produced from 12.5–66.6 per cent smut on this host. In contrast, Canadian oats was infected to the extent of from 21.8–92.3 per cent smut by the hybrid spores, 82.6 and 92.9 per cent by the two *U. Avenae* parents, and 5.2, 8.4, and 12.2 per cent by the three field collections of *U. perennans*. Apparently this is the first report of the infection of cultivated oats with *U. perennans*.

Among the smutted panicles produced by the F_2 generation of each hybrid involving the indurate race of *U. Avenae* (U. A. 54 $\times$ U. p. 8, 1 $\times$ 3,[3] and U. A. 54 $\times$ U. p. 8, 4 $\times$ 3) there were four types of segregates. These types, as shown in figure 1, represented different combinations of the four sorus characters involved (covered, naked, powdery, and indurate). In addition to the covered indurate and naked indurate segregates, the covered powdery and naked powdery parent types were produced in the F_2 on Canadian oats (fig. 1, *A*, *B*, *C*, and *D*, respectively). Apparently, therefore, the factors governing the four sorus characters involved in these hybrids are inherited independently. The two crosses in which the naked powdery *U. Avenae* parent was involved (U. A. 56 $\times$ U. p. 8, 1 $\times$ 3 and 4 $\times$ 3) segregated into covered powdery and naked powdery sori, the *U. perennans* and *U. Avenae* types, respectively.

F_3 Generation

The results of the inoculations with F_2 spores are presented in Table 2. Some infection was obtained from all of the inoculations on each of the three oat varieties, but again no infection of tall oatgrass by the hybrid chlamydospores was obtained. A high degree of susceptibility to the three collections of *Ustilago perennans* was exhibited by the three oat varieties. These collections of *U. perennans* were the same as those that produced the infection on tall oatgrass and Canadian oats shown in Table 1. Smutted panicles of the three oat varieties resulting from inoculation with *U. perennans* are shown in figure 2.

Segregation in the F_3 generation of the cross between the indurate sorus race of *Ustilago Avenae* with *U. perennans* (U. A.

[3] U. A. 54 and U. p. 8 designate the promycelia selected, of *Ustilago Avenae* and *U. perennans*, respectively, while 1 $\times$ 3 indicates the sporidial combination of the two species, respectively. (See footnote 1, Table 2.)

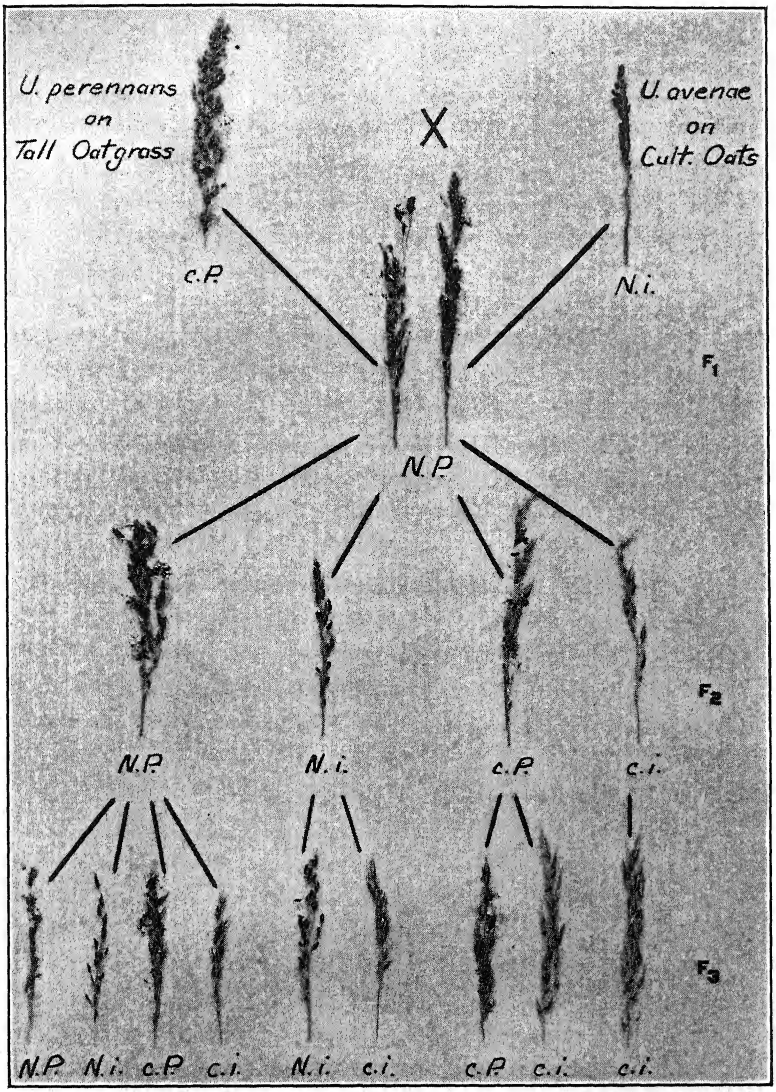

FIG. 3. Parental and F_1 sorus types and F_2, and F_3 segregates from a cross between *Ustilago Avenae* × *U. perennans*. F_1 on *Avena fatua*, F_2 and F_3 on *Avena sativa*. Legend: c.P. = covered powdery sori; N.i. = naked indurate sori; N.P. = naked powdery sori; c.i. = covered indurate sori. The dominance of powdery over indurate sori is indicated by upper case "P" for the former and lower case "i" for the latter. The dominance of naked over covered sori is indicated by upper case "N" for the former, and lower case "c" for the latter. Approx. ⅓ nat. size.

54 × U. p. 8, 1 × 3 and 4 × 3) further indicated that the powdery sorus character is dominant over the indurate character, as was found to be true in crosses between races of *U. Avenae* (3), and that the naked character of the *Avenae* parent is dominant over the covered character of the *perennans* parent. The sorus types produced by the parent species of this cross and the first three hybrid generations are shown in figure 3. As already pointed out, the F_1 sori on wild oats were powdery and in the F_2 generation on Canadian oats the sori were naked powdery, naked indurate, covered powdery, and covered indurate sori. The genetic nature of these segregates is indicated by the F_3 segregates shown in figure 3. The naked powdery type produced the four types observed in the F_2, thus indicating heterozygosity for all four characters. The naked indurate type segregated into naked indurate and covered indurate sori, indicating homozygosity for the indurate character and heterozygosity for the naked character. In contrast the covered powdery type segregated into covered powdery and covered indurate sori, indicating that it was homozygous for the covered character and heterozygous for powdery. The covered indurate type bred true, indicating that it was doubly homozygous. These results might have been expected on a theoretical basis, assuming complete dominance of the naked over the covered character, as was indicated in the F_1, and on the basis of heritability of the powdery and indurate characters (3).

As already stated, the two hybrids which involved the naked powdery race of *Ustilago Avenae* (U. A. 56 × U. p. 8, 1 × 3 and 4 × 3) segregated in the F_2 into the two parent types, indicating that the naked character is dominant over the covered. The naked F_2 segregates selected for inoculum produced naked and covered F_3 segregates, indicating that the former were heterozygous. The covered F_2 segregates produced only the covered type, indicating that they were homozygous.

DISCUSSION

The infection of cultivated oats with *Ustilago perennans* and the production of several hybrids between *U. perennans* and *U. Avenae* have a direct theoretical bearing on the possible relationship between the two species. McAlpine (7) and Cunningham (2) have

both held that the tall oatgrass smut does not merit specific distinction from *U. Avenae*. Inasmuch as the two species are indistinguishable on the basis of the morphology and germination of their spores this view seems logical, even if *U. perennans* were specialized to tall oatgrass and *U. Avenae* to *Avena* spp. Rösch (8) compared *U. perennans* and *U. Avenae* closely and concluded that they are very similar, both in saprophytic and parasitic existence, but that they are not identical in germination. Hüttig (5) found slight biophysical differences between the two species. These differences, however, are no more significant as species distinctions than similar or even greater differences which frequently exist between physiologic races of other species of parasitic fungi. The now established fact that *U. perennans* and *U. Avenae* can be hybridized, and that at least some oat varieties are decidedly susceptible to *U. perennans* would seem to be sufficient evidence that *U. Avenae* and *U. perennans* are one species.

A consideration of the complete synonomy furnished by Liro (6) indicates that originally the tall oatgrass smut and the loose smut of oats were considered as belonging to the old species *Uredo segetum* Persoon, and that Wallroth in 1815 recognized the tall oatgrass smut as *Uredo segetum decipiens*. The binomial at present most widely used for this smut is *Ustilago perennans,* the name proposed by Rostrup in 1890. Liro (6) maintained correctly that the oldest specific epithet should apply to the smut, and accordingly designated it as *Ustilago decipiens* (Wallroth) Liro. This name merits preference, to conform to International Rules of Botanical Nomenclature. The earliest specific designation given to the loose smut of oats was *Uredo segetum Avenae,* by Persoon in 1801 (1797 according to Clinton (1)). In 1889 Jensen assigned this smut to the genus *Ustilago* as *U. Avenae,* the name which is now universally recognized.

In consideration of the brief history of the synonomy of the two species of *Ustilago* in question, the name *U. Avenae* (Pers.) Jensen has priority over *U. decipiens* (Wallroth) Liro. Therefore, if consolidation of the two species is justifiable the former binomial should apply, and, on this basis, *U. perennans* would be recognized as a race of *U. Avenae*.

SUMMARY

Further evidence is presented that *Ustilago Avenae* and *U. perennans* will hybridize.

Crosses between *Ustilago Avenae* and *U. perennans* were made which involved four sorus characters, namely, covered, naked, powdery, and indurate.

The naked and powdery characters were found to be dominant over covered and indurate, respectively.

Independent inheritance of these characters is indicated by the fact that naked powdery, naked indurate, covered powdery, and covered indurate segregates were produced in the F_2 generation. These segregates broke up in the F_3 generation as follows: the naked powdery segregate gave rise to all four of the above-mentioned segregates; the naked indurate segregate produced naked indurate and covered indurate types; the covered powdery segregate produced covered powdery and covered indurate types; and the covered indurate segregate proved to be doubly homozygous in yielding only the covered indurate type of sorus. In crosses of *U. perennans* with a race of *U. Avenae* having normal powdery sori, only the covered vs. the naked sorus characters were studied. Again it was found that the naked sorus character is dominant over the covered sorus character.

The susceptibility of cultivated oats to *Ustilago perennans* was demonstrated, but tall oatgrass has not been found to be susceptible to *U. Avenae* nor to the hybrids between these two smuts.

That *Ustilago Avenae* and *U. perennans* are synonymous is indicated by the morphological identity of their chlamydospores, their genetic relationship, and host range.

A consolidated species would, by priority, be designated as *Ustilago Avenae* (Pers.) Jensen.

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NOTES AND BRIEF ARTICLES

RELATIVE DATES OF S. F. GRAY'S NATURAL ARRANGEMENT AND FRIES'S SYSTEMA

In the section of S. F. Gray's *Natural Arrangement of British Plants* [1] devoted to fungi was published a number of small and for the most part homogeneous genera of Hymenomycetes, since buried in the large and broadly defined groups of Fries, but often needed in the more precise mycological taxonomy of recent years. The use of these genera has frequently been limited by the doubt held by most mycologists whether the nomenclature of Gray's treatment, published in the same year as the first volume of the *Systema Mycologicum,* was available under the Rules—the uncertainty, that is, whether the *Natural Arrangement* was published after, or before, the *Systema.* In Seymour's host index [2] there is a footnote which reads: "In this work, S. F. Gray's Natural Arrangement of British Plants, 1821, is considered to be later than Fries, Systema Mycologicum, also 1821." The indication of this footnote has been followed by Miller,[3] in monographing the Hydnaceae, and by Cooke,[4] in discussing genera of the pore-fungi; but the evidence upon which Seymour's conclusion was based is not known, and none seems to have been presented elsewhere.[5] There is room for the suspicion that Gray's work has been neglected as being non-Friesian to the same extent to which it was earlier condemned [6] for being non-Linnaean.

Although the absolute dates of the two works cannot be accurately established by any evidence now at hand, their relative dates can be determined so as to leave no reasonable occasion for doubt. The engraved plates forming a part of the *Natural Arrangement*

[1] **1**: 507–676. 1821.
[2] Host index fungi N. Am. ix. 1929.
[3] Mycologia **25**: 286–302. 1933.
[4] Lloydia **3**: 81–104. 1940.
[5] Cf. Dodge, Mo. Bot. Gard. Ann. **21**: 709–710. 1934.
[6] Cf. Jour. Bot. **10**: 374–375. 1872.

are marked at the foot: "London, Published by Baldwin, Cradock & Joy, Paternoster Row, Nov^{r}. 1st. 1821"; and there is no reason to suspect that they appeared before that date. For the first volume of the *Systema,* the only date given other than the year 1821 on the title-page is the one that appears at the end of the "Ratio Operis," on p. [viii]: "Dabam Lundae in Suecia d. 16 Nov. 1820." According to custom that date should mark the completion of the printing of the body of the work; but it still is not conclusive for the date of publication. However, in a "Historiola Studii mei Mycologici" which forms an introduction to Fries's *Monographia Hymenomycetum* [7] (and is quoted in the introduction to his *Icones* [8]), Fries wrote: "In the autumn of 1819 I brought back a greater abundance [of fungi] from the forests of Scania, with the result that many species then collected could be inserted in the first volume of the Systema Mycologicum, which went to press in that same year and was completed (absolutum est) in the following; however, the publisher caused the year on the title-page (in indice) of the book to read 1821." The time of appearance of the *Systema* was then, according to Fries, very late in 1820 (of necessity later than November 16th); it can scarcely have been after the very beginning of 1821. Unless proof to the contrary appears, the date for the purposes of the rules may well, on the grounds of Fries's statement, be considered to be January 1st, 1821.

Gray's *Natural Arrangement,* it follows, is post-Friesian, and the groups of Hymenomycetes published in it may be taken into account in tracing nomenclature or arriving at typification. It has recently been asserted [9] that the genus *Perispherostoma* Gray is "invalid because pre-*Systema.*" Whether any general statement concerning Gray's work is intended is not apparent. The genus in question is pyrenomycetous; it may be that no more was meant than that the nomenclature of the Pyrenomycetes commences with the second volume of the *Systema,* which presumably is later than the *Natural Arrangement.* Even if the latter be the intention, the nomenclature committee of the British Mycological Society has

[7] Monogr. Hym. Suec. viii. 1857.
[8] Icones Sel. Hym. 2: ii. 1884.
[9] Trans. Brit. Myc. Soc. 24: 283. 1940.

gone beyond the rules in the assertion quoted. The very useful and important motion placed before the last International Congress by Dodge (l. c.) to clarify mycological nomenclature by recognizing the year 1821, rather than the whole series of dates on which various parts of the *Systema* appeared, as a starting-point was left to a committee,[10] and ultimately to the next Congress, for action, and so there exists no authority for declaring a name invalid because pre-*Systema* unless it actually antedates the whole of the *Systema;* either interpretation of the starting-point rule (Art. 25, f) is at present permissible. The availability of Gray's nomenclature for some groups of fungi is therefore still open to doubt; for the Hymenomycetes, it is not only useful, but usable.—DONALD P. ROGERS.

MYCOLOGICAL SOCIETY OF AMERICA

REPORT ON THE 1939 FORAY

The 1939 Summer Foray of the Mycological Society of America was held in the Great Smoky Mountain National Forest where facilities for the studying and drying of specimens were provided at the Park Naturalists' Headquarters. To the Park Naturalists, and especially to Mr. Arthur K. Stupka, Park Naturalist, and Mr. Parker of the same service, the Society at its business meeting expressed its hearty thanks for their unfailing courtesy, cooperation and assistance, which made possible a most pleasant and profitable stay in an extremely beautiful region. The help of the Park Naturalists plus that of two members of our own society, Drs. L. R. Hesler and A. H. Smith, who had already done much collecting in the National Forest, enabled the members to proceed without undue delay to the most productive collecting grounds and as a result, in spite of the dry weeks that had preceded the foray, the members returned with ample collections for study during the evenings.

Those submitting reports (only eight out of thirty-three members) are listed below, preceded by a symbol which indicates the

[10] Zesde Int. Bot. Congr. Proc. 1: 341, 368. 1936.

name of the person who made the collections, or the institution in which they are preserved.

F = David H. Linder, Farlow Herbarium, Harvard University
H = Robert Hagelstein and Joseph H. Rispaud, New York Botanical Garden
M = Alexander H. Smith, University of Michigan
O = L. O. Overholts, Pennsylvania State College
S = Walter H. Snell, Brown University
W = Ross W. Davidson, C. L. Shear, John A. Stevenson, Bureau of Plant Industry, Washington, D. C.

MYXOMYCETES: *Arcyria cinerea* (Bull.) Pers. (H); *A. denudata* (L.) Wettst. (F, H); *A. incarnata* Pers. (H); *Ceratiomyxa fruticulosa* (Muell.) Macbr. (H); *Clastoderma Debaryanum* Blytt (H); *Comatricha pulchella* (Bab.) Rost. (H); *C. typhoides* (Bull.) Rost. (H); *Cribraria elegans* Berk. & Curt. (H); *C. intricata* Schrad. (H); *C. intricata* var. *dictyoides* (Cke. & Balf.) List. (H); *C. splendens* (Schrad.) Pers. (H); *C. tenella* Schrad. (H); *Diachea bulbillosa* (Berk. & Br.) List. (H); *D. leucopodia* (Bull.) Rost. (H); *Dictydiaethalium plumbeum* (Schum.) Rost. (H); *Dictydium cancellatum* (Batsch) Macbr. (H); *Diderma effusum* (Schw.) Morg. (H); *D. hemisphaericum* (Bull.) Hornem. (H); *D. rugosum* (Rex) Macbr. (H); *D. testaceum* (Schrad.) Pers. (H, W); *Didymium crustaceum* Fr. (H); *D. nigripes* (Lk.) Fr. (H); *D. squamulosum* (Alb. & Schw.) Fr. (H); *D. xanthopus* (Ditm.) Fr. (H); *Enerthenema papillatum* (Pers.) Rost. (H); *Fuligo septica* (L.) Weber (H); *F. septica* var. *rufa* Pers. (H); *Hemitrichia clavata* (Pers.) Rost. (H); *H. Serpula* (Scop.) Rost. (H); *H. Vesparium* (Batsch) Macbr. (H); *Lamproderma arcyrionema* Rost. (H); *L. columbinum* (Pers.) Rost. (H); *Leocarpus fragilis* (Dicks.) Rost. (H); *Lycogala epidendrum* (L.) Fr. (H); *Lycogala epidendrum* var. *exiguum* (Morg.) List. (H); *Oligonema flavidum* Peck (H); *Perichaena chrysosperma* (Currey) List. (H); *Physarum cinereum* (Batsch) Pers. (H); *P. citrinellum* Peck (H); *P. contextum* Pers. (H); *P. globuliferum* (Bull.) Pers. (H); *P. lateritium* (Berk. & Rav.) Morg. (H); *P. leucopus* Link (H); *P. Listeri* Macbr. (H); *P. melleum* (Berk. & Br.) Massee (H); *P. nucleatum* Rex (H); *P. nutans* Pers. (H); *P. penetrale* Rex (H); *P. psittacinum* Ditm. (H); *P. pulcherrimum* Berk. & Rav. (H); *P. sinuosum* (Bull.) Weinm. (H);

P. sulphureum Alb. & Schw. (H); *P. sulphureum* var. *sessile* G. List. (H); *P. superbum* Hagelstein (H); *P. tenerum* Rex (H); *P. viride* (Bull.) Pers. (H); *Prototrichia metallica* (Berk.) Macbr. (H); *Stemonitis axifera* (Bull.) Macbr. (H); *S. fusca* Roth (H); *S. pallida* Wing. (H); *S. splendens* Rost. (H); *Trichia Botrytis* (Gmel.) Pers. (H); *T. decipiens* (Pers.) Macbr. (H); *T. erecta* Rex (H); *T. favoginea* (Batsch) Pers. (H); *T. floriformis* (Schw.) G. List. (H); *T. persimilis* Karst. (H); *T. subfusca* Rex (H); *T. varia* Pers. (H).

PHYCOMYCETES: *Albugo Ipomoeae-panduranae* (Farl.) Swing. (W); *Plasmopara viticola* (Berk. & Curt.) Wilson (O); *Synchytrium decipiens* Farl. (F, O, W).

PLECTACALES: *Elaphomyces appalachiensis* Linder (F, M, W); *E. variegatus* Vitt. (F, W).

PYRENOMYCETES (sensu latu): *Adelopus balsamicola* (Pk.) Theiss. (W); *Anthostomella sepelibilis* (Berk. & Curt.) Sacc (W); *Balansia Hypoxylon* (Pk.) Atk. (W); *Botryosphaeria Ribis* (Tode ex Fr.) Grossenb. & Duggar (W); *Caliciopsis pinea* Pk. (W); *Camarops pugillus* (Schw.) Shear (W); *Chromocreopsis cubispora* (Ell. & Holw.) Seaver (W); *Clypeolella Leemingii* (Ell. & Ev.) Theiss. (W); *Cordyceps agariciformia* (Bolt.) Seaver (F); *C. intermedia* Imai (F, M, W); *C. militaris* (L.) Link (F, O); *C. michiganensis* Mains (W); *C. ophioglossoides* (Ehr. ex Fr.) Link (F, W); *C. parasitica* (Willd.) Seaver (O); *C. sphecophila* (Kl.) Mass. (F, O, W); *Creonectria cucurbitula* (Sacc.) Seaver (W); *Cryptodiaporthe aculeans* (Schw.) Wehm. (F, W); *Daldinia concentrica* (Bolt. ex Fr.) Ces. & deNot. (W); *Diatrypella discoidea* Cke. & Pk. var. *Alni* Cke. (W); *Dimerosporium Tsugae* Dearn. (W); *Dothichloe atramentosa* (Berk. & Curt.) Atk. (W); *Endothia parasitica* (Murr.) Anders. & Anders. (W); *Erysiphe Cichoracearum* DC. (W); *Fracchiaea heterogenea* Sacc. (W); *Glonium stellatum* Muhl. (W); *Gnomonia ulmea* (Sacc.) Thuem. (W); *Hypocrea gelatinosa* Tode ex Fr. (O); *H. patella* Cke. & Pk. (W); *H. rufa* Pers. ex Fr. (F); *H. rufula* Pers. ex Fr. (W); *Hypoderma brachysporum* (Rost.) Tub. (O); *H. commune* (Fr.) Duby (W); *Hypomyces aurantius* (Pers. ex Fr.) Tul. (W); *H. chrysospermus* Tul. (F, W); *H. lactifluorum* (Schw.) Tul. (O); *H. rosellus* (S. & S.) Tul. (F); *Hypoxylon*

commutatum Nke. (W); *H. fuscum* (Pers. ex Fr.) Fr. (W); *H. rubiginosum* (Pers. ex Fr.) Fr. (W); *Hysterium insidens* Schw. (W); *Hysterographium Mori* (Schw.) Rehm (W); *H. vulvatum* (Schw.) Sacc. (W); *Lasiosphaeria ovina* (Pers. ex Fr.) Ces. & deNot. (W); *Meliola bidentata* Cke. (W); *Microsphaera Alni* var. *Vaccinii* (Schw.) Salmon (O); *Myriangium Duriaei* Mont. & Berk. (F); *Nectria cinnabarina* Tode ex Fr. (W); *N. flavo-ciliata* Seaver (W); *N. ochroleuca* Schw. (W); *N. Peziza* Tode ex Fr. (W); *Nummularia tinctor* (Berk.) Ell. & Ev. (W); *Peckiella lateritia* (Fr.) Maire (W); *Phyllachora Lespedezae* (Schw.) Sacc. (F, W); *P. vulgata* Theiss. & Syd. (W); *Physalospora Rhododendri* (deNot.) Sacc. (W); *Rhytisma Vaccinii* (Schw.) Fr. (F, W); *Rosellinia Clavariae* (Tul.) Winter (O); *R. subiculata* (Schw.) Sacc. (W); *Scoleconectria balsamea* (Cke. & Pk.) Seaver (W); *Ustulina vulgaris* Tul. (W); *Xylaria Hypoxylon* (L.) Grev. (S); *X. polymorpha* (Pers.) Grev. (O).

DISCOMYCETES: *Aleuria cestrica* (Ell. & Ev.) Seaver (W); *Belonidium introspectum* (Cke.) Sacc. (W); *Calycina macrospora* (Pk.) Seaver (W); *Chlorosplenium aeruginascens* (Nyl.) Karst. (W); *C. chlora* (Schw.) Curt. (W); *C. versiforme* (Pers. ex Fr.) Karst. (W); *Coryne sarcoides* (Jacq. ex Fr.) Tul. (W); *Cyathicula petiolorum* (Rob. & Desm.) Sacc. (W); *Dasyscypha Agassizii* (Berk. & Curt.) Sacc. (W); *D. cerina* (Pers. ex Fr.) Fckl. (W); *D. nivea* (Fr.) Sacc. (W); *Dermatea balsamea* (Pk.) Seaver (W); *D. Cerasi* (Pers. ex Fr.) deNot. (W); *Geoglossum glabrum* (Pers.) Fr. (O); *Gloeoglossum difforme* (Fr.) Durand (F, O, S, W); *Helotium epiphyllum* (Pers.) Fr. (F, W); *H. phyllophilum* (Desm.) Karst. (O); *H. saprophyllum* Pk. (F); *H. scutula* (Pers. ex Fr.) Karst. (W); *Helvella atra* Oed. (O); *Ionomidotis fulvo-tingens* (Berk. & Curt.) Cash (W); *Lachnum sulfureum* (Pers. ex Fr.) Rehm (W); *Leotia lubrica* (Scop.) Fr. (O); *L. stipitata* (Bosc.) Schroet. (F, W); *Mollisia fumigata* (Ell. & Ev.) Sacc. (W); *M. melaleuca* (Fr.) Sacc. (W); *Patella albida* (Schaeff.) Seaver (W); *P. scutellata* (L.) Morg. (W); *Paxina fuscicarpa* Seaver (F); *P. hispida* (Schaeff.) Seaver (W); *Pezicula carnea* (Cke. & Ell.) Rehm (O); *P. Rubi* (Lib.) Niessl (W); *Peziza badia* Pers. ex Fr. (W); *P. violacea* Pers. (O); *Propolis faginea* (Schrad.) Karst. (W); *Rutstroemia macrospora*

(Pk.) Kanouse (F); *Sarcosoma carolinianum* Durand (W); *Schizoxylon insigne* (deNot.) Rehm (W); *Trichoglossum hirsutum* (Pers.) Boud. (O, W); *Tympanis conspersa* Fr. (W).

TUBERALES: *Hydnotria cubispora* (Bessey & Thompson) Gilkey (F); *Tuber separans* Gilkey (F).

UREDINALES: *Chrysomyxa roanensis* Arth. (W); *Coleosporium Elephantopodis* (Schw.) Thuem. (F, O, W); *C. Helianthi* (Schw.) Arth. (F); *C. inconspicuum* (Long) Hedgc. & Long (W); *C. Solidaginis* (Schw.) Thuem. (F, O, W); *C. Vernoniae* Berk. & Curt. (F, O, W); *Cronartium Quercuum* (Berk.) Miy. (W); *Gymnoconia Peckiana* (Howe) Trotter (F); *Kuehneola uredinis* (Lk.) Arth. (W); *Puccinia Circaeae* Pers. (O); *P. extensicola* var. *Solidaginis* (Schw.) Arth. (W); *P. marylandica* Lindr. (F, W); *P. tenuis* (Schw.) Burr. (O); *P. Verbesinae* Schw. (O, W); *Pucciniastrum Agrimoniae* (Schw.) Trans. (F, O, W); *P. Hydrangeae* (Berk. & Curt.) Arth. (F, O, W); *Uredinopsis macrosperma* (Cke.) Magn. (O); *U. mirabilis* (Pk.) Magn. (W); *Uromyces Hedysari-paniculati* (Schw.) Farl. (O); *U. Holwayi* Lagerh. (W); *U. Hyperici* (Spreng.) Curt. (F, O, W); *U. Lespedezae-procumbentis* (Schw.) Curt. (F, W).

PROTOBASIDIOMYCETES (except Uredinales): *Exidia glandulosa* (Bull.) Fr. (O); *Naematelea nucleata* (Schw.) Fr. (O); *Phleogena faginea* (Fr.) Lk. (F, W); *Platygloea Peniophorae* Bourd. & Galz. (F); *Sebacina incrustans* (Pers.) Tul. (O); *Septobasidium Curtisii* (Berk. & Desm.) Boed. & Steinm. (F); *Tremellodendron merismatoides* (Schw.) Burt (O, S); *T. pallidum* (Schw.) Burt (O, S); *Tremellodon gelatinosum* (Scop. ex Fr.) Pers. (O, S, W).

THELEPHORACEAE: *Aleurodiscus amorphus* Pers. ex Rabh. (W); *Asterostroma ochroleucum* Bres. (F); *Botryobasidium isabellinum* (Fr.) Rogers (F); *Ceratobasidium plumbeum* Martin (F); *Coniophora arida* (Fr.) Karst. (W); *Corticium investiens* (Schw.) Bres. (S); *C. octosporum* Schroet. (F); *C. radiosum* Fr. (O); *Corticium vagum* (Berk. & Curt.) Rogers (F); *Craterellus cantharellus* (Schw.) Fr. (O, S); *C. cornucopioides* (Schw.) Fr. (O); *C. odoratus* (Schw.) Fr. (O); *Cyphella cupulaeformis* Berk. & Rav. (W); *Hymenochaete corrugata* (Fr.) Lév. (F, W); *H. rubiginosa* (Dicks. ex Fr.) Lév. (W); *H. tabacina* (Sow. ex Fr.) Lév. (W); *Hypochnus* (=*Tomentella*) *fumosus* Fr. (O);

H. polyporoideus (Schw.) Overh. (W); *H. rubiginosus* Bres. (W); *Peniophora Pirina* Bourd. & Galz. (F); *Solenia? Brenckleanus* Sacc. (W); *S. anomala* (Pers.) Fckl. (W); *S. fasciculata* Pers. ex Fr. (W); *Stereum ambiguum* Pk. (W); *S. Burtianum* Pk. (O, S, W); *S. fasciatum* Schw. ex Fr. (O, W); *S. Chaillettii* Pers. (O); *S. lobatum* (Kze.) Fr. (F); *S. pallidum* (Pers.) Lloyd (F); *S. rameale* Schw. (O, W); *S. Ravenelii* Berk. & Curt. (F); *S. rugosum* Pers. ex Fr. (W); *S. sanguineolentum* (Alb. & Schw. ex Fr.) Fr. (W); *S. sulcatum* Burt (W); *Thelephora anthocephala* Bull. ex Fr. (W); *T. vialis* Schw. (O).

CLAVARIACEAE: *Clavaria botrytis* Pers. (F, O); *C. cristata* Holmsk. ex Fr. (F, O); *C. fennica* Karst. (O); *C. formosa* (Pers.) Fr. (F, O); *C. fusiformis* Sowerb. (F); *C. grandis* Pk. (O); *C. Kunzei* Fr. (F, O); *C. mucida* (Pers.) Fr. (O); *C. muscoides* L. (F); *C. obtusissima* Pk. (O); *C. pulchra* Pk. (O, W); *C. rufescens* (Schaeff.) Fr. (O); *C. subfalcata* Atk. (F); *Sparassis crispa* (Wulf.) Fr. (O).

HYDNACEAE: *Calodon amicum* Quel. (F); *C. scrobiculatum* (Fr.) Quel. (F); *C. zonatum* (Fr.) Quel. (F, O); *Hydnum alboniger* Pk. (O); *H. Ellisianum* (Bank.) Sacc. & Trott. (O); *H. fennicum* Karst. (O); *H. fuligineo-violaceum* Kalchbr. (O); *H. graveolens* (Delast.) Fr. (O); *H. imbricatum* (L.) Fr. (O); *H. ochraceum* Pers. ex Fr. (W); *H. repandum* L. (F, O); *H. rufescens* (Pers.) Fr. (O); *H. velutinum* Fr. (O); *Irpex cinnamomeus* Fr. (O, W); *I. farinaceus* Fr. (W); *Odontia arguta* (Fr.) Quel. (F).

POLYPORACEAE: *Daedalea confragosa* Bolt. ex Fr. (W); *Favolus Rhipidium* Berk. (O, S); *Fistulina hepatica* (Huds.) Fr. (O, S, W); *Fomes connatus* (Weinm.) Gill. (F); *F. igniarius* var. *laevigatus* (Fr.) Overh. (O); *F. lobatus* (Schw.) Cke. (O); *F. Pini* (Brot. ex Fr.) Karst. (W); *F. subroseus* (Weir) Overh. (O, W); *Lenzites betulina* (L.) Fr. (O, W); *L. saepiaria* Wulf. ex Fr. (W); *Merulius molluscus* Fr. (O); *Polyporus abietinus* Dicks. ex Fr. (O, W); *P. cinnamomeus* (Jacq.) Sacc. (F); *P. cristatus* (Pers.) Fr. (O); *P. elegans* Bull. ex Fr. (O, W); *P. fissilis* Berk. & Curt. (O); *P. hirsutus* Wulf. ex Fr. (W); *P. pargamenus* Fr. (F, W); *P. Pes-Caprae* (Pers.) Fr. (O); *P. pocula* (Schw.) Berk. & Curt. (W); *P. pubescens* Schum. ex Fr. (W); *P. radiatus* Sow. ex Fr. (O, S, W); *P. Schweinitzii* Fr. (S); *P. semipileatus*

Pk. (S); *P. semisupinus* Berk. & Curt. (W); *P. Spraguei* Berk. & Curt. (O, S, W); *P. sulphureus* Bull. ex Fr. (O); *P. versicolor* L. ex Fr. (F, O, W); *Poria spissa* Schw. (O); *P. subacida* Pk. (O).

BOLETACEAE: *Boletinus castanellus* Pk. (O, S); *B. pictus* Pk. (S); *B. squarrosoides* Snell & Dick (S); *Boletus affinis* Pk. (S); *B. alboater* Schw. (S); *B. auriflammeus* Berk. & Curt. (F, S); *B. auriporus* Pk. (S); *B. badius* Fr. (S, W); *B. bicolor* Pk. (O, S); *B. castaneus* Bull. ex Fr. (O, S); *B. chromapes* Frost (S); *B. chrysenteroides* Snell (O); *B. cyanescens* Bull. ex Fr. (F, S); *B. felleus* Bull. ex Fr. (S); *B. fumosipes* Pk. (S); *B. glutinosipes* Snell & Hesler (S); *B. gracilis* Pk. (O, S); *B. granulatus* L. ex Fr. (S); *B. longicurvipes* Snell & Smith (S); *B. ornatipes* Pk. (O, S); *B. pallidus* Frost (S); *B. parasiticus* Bull. ex Fr. (F, S); *B. Peckii* Frost (S); *B. piperatus* Bull. ex Fr. (O, S); *B. porphyrosporus* Fr. (S); *B. rubeus* Frost (S); *B. rubinellus* Pk. (O, S); *B. scaber* Bull. ex Fr. (O, S); *B. separans* Pk. (O); *B. subglabripes* Pk. (S); *B. subtomentosus* L. ex Fr. (S); *B. subvelutipes* Pk. (S); *Strobilomyces strobilaceus* (Scop. ex Fr.) Berk. (S).

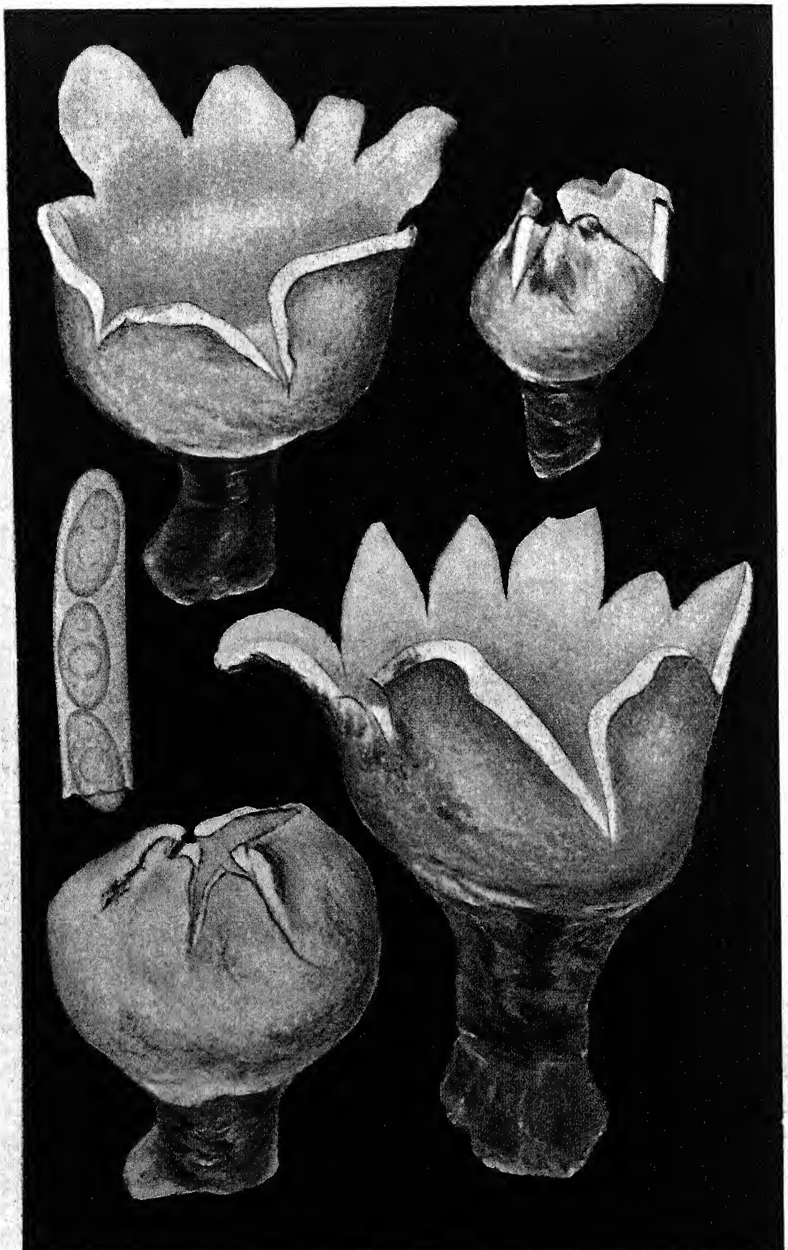
AGARICACEAE: *Agaricus placomyces* Pk. (O); *A. sylvicolus* Vitt. (O); *Amanita bisporiger* Atk. (O); *A. chlorinosma* Pk. (O); *A. cinereoconia* Atk. (F); *A. spreta* Pk. (O); *Amanitopsis parcivolvata* Pk. (O); *A. vaginata* (Bull.) Roze (O); *Armillaria mellea* (Vahl) Fr. (O); *Cantharellus aurantiacus* Fr. (S); *C. cinnabarinus* Schw. (O, S); *C. floccosus* Schw. (O, S); *C. minor* Pk. (O); *Clitocybe cyathiformis* Bull. ex Fr. (O); *C. illudens* Schw. (F, O); *C. laccata* Scop. ex Fr. (O); *C. ochropurpurea* Berk. (O, S, W); *C. parilis* Fr. (O); *Clitopilus orcellus* Fr. (O); *Collybia abundans* Pk. (O); *C. colorea* Pk. (O); *C. conigenoides* Ellis (O); *C. conigena* Fr. sensu Bres. (F); *C. dryophila* Bull. ex Fr. (O); *C. exsculpata* (Fr.) Gillet (M); *C. flaccida* Smith & Hesler (M); *C. maculata* Alb. & Schw. (O); *C. platyphylla* Fr. (O); *C. radicata* (Relk.) Fr. (O); *Cortinarius cinnabarinus* Fr. (O); *C. croceofolius* Pk. (O); *C. flavifolius* Pk. (M, O); *C. ioides* Berk. & Curt. (S); *C. purpurascens* Fr. (F, M); *C. semisanguineus* (Fr.) Kauffm. (O); *Crepidotus applanatus* Fr. (O); *C. haerens* Pk. (O); *C. herbarum* Pk. (F, O); *Entoloma cuspi-*

datum Pk. (O); *E. cyaneum* Pk. (M); *Flammula polychroa* Berk. (O); *Hygrophorus conicus* Fr. (M, O); *H. marginatus* Pk. (O); *H. miniatus* Fr. (O); *H. Peckii* Atk. (O); *Hypholoma delineatum* Pk. (O); *H. fasciculare* (Huds.) Fr. (O); *Inocybe lilacina* (Boud.) Kauffm. (O); *Lactarius Allardii* Coker (O); *L. atroviridis* Pk. (O); *L. camphoratus* Bull. ex Fr. (O); *L. chrysopheus* Fr. (O); *L. cinereus* Pk. (O); *L. corrugis* Pk. (O); *L. croceus* Burl. (M, O); *L. deliciosus* (L.) Fr. (O); *L. fuliginosus* Fr. (F, O); *L. Gerardii* Pk. (O); *L. glaucescens* Crossl. (O); *L. griseus* Pk. (O); *L. hygrophoroides* Berk. & Curt. (O); *L. indigo* (Schw.) Fr. (M, O); *L. lignyotus* Fr. (O); *L. maculatus* Pk. (O); *L. piperatus* Fr. (O); *L. plinthogalus* (Otto) Burl. (O, S); *L. pyrogalus* Fr. (S); *L. rimocellus* Pk. (O); *L. rusticanus* (Scop.) Burl. (O); *L. subdulcis* (Pers.) Fr. (O); *L. subplinthogalus* Coker (O, S); *L. subpurpureus* Pk. (S); *L. theiogalus* Fr. (S); *L. trivialis* Fr. (O); *L. vellereus* Fr. (O); *L. volemus* Fr. (O, S); *Lepiota Grangei* (Eyre) Lange (M); *L. lutea* (Bolt.) Quel. (M, S); *Leptonia strictius* Pk. (O); *Marasmius albiceps* Pk. (O); *M. androsaceus* Fr. (O); *M. felix* Morgan (O); *M. magnisporus* Murr. (F, O, W); *M. resinosus* Pk. (O); *M. siccus* Schw. (O); *M. subnudus* (Ell.) Pk. (O); *Mycena carolinensis* Smith & Hesler (M); *M. clavicularis* Fr. (S); *M. galoppus* (Fr.) Quel. (M); *M. leaiana* Berk. (O); *M. odorifera* Pk. (O); *M. rubromarginata* Fr. (F, M, O); *Nolanea dysthales* (Pk.) Atk. (O); *Omphalia stromboides* (Berk. & Mont.) Sacc. (M); *Panus levis* Berk. & Curt. (O); *P. stipticus* Fr. (O, W); *Paxillus atrotomentosus* Fr. (O); *P. involutus* Fr. (F); *P. pannuoides* Fr. (O); *Pleurotus griseus* Pk. (O); *P. petaloides* Fr. (O); *Pluteolus calestus* Pk. (M); *P. coprophilus* Pk. (O); *Pluteus admirabilis* Pk. (O); *P. cervinus* (Schaeff.) Fr. (O); *P. nanus* Fr. (O); *Russula crustosa* Pk. (S); *R. pectinatoides* Pk. (O); *R. rubescens* Beards. (S); *Stropharia Hardii* Atk. (M); *Tricholoma sejunctum* Fr. (O).

GASTEROMYCETES: *Astraeus hygrometricus* (Pers.) Morg. (F); *Calostoma cinnabarina* Desv. (F, O, S); *C. Ravenelii* (Berk.) Mass. (F); *Crucibulum vulgare* Tul. (O); *Lycoperdon fuscum* Bon. (W); *L. gemmatum* Batsch (O); *Mutinus Curtisii* (Berk.)

Fisch. (O); *Scleroderma cepa* Vaill. ex Fr. (W); *S. Geaster* Fr. (F); *S. vulgare* (Hornem.) Fr. (O).

FUNGI IMPERFECTI: *Arthrobotryum atrum* Berk. & Br. (O); *Asteroma Lactucae* J. J. Davis (F, W); *Camarosporium Robiniae* (Westd.) Sacc. (W); *Cercospora atromaculans* Ell. & Ev. (F); *C. Boehmeriae* Pk. (F, W); *C. Diodiae-virginianae* Atk. (F, W); *C. effusa* Berk. & Curt. (F, W); *C. erythrogena* Atk. (F, W); *C. granuliformis* Ell. & Halst. (W); *C. Kalmiae* Ell. & Ev. (W); *C. Rhoina* Cke. & Ell. (F, O, W); *C. smilacina* Sacc. (F, O, W); *C. Smilacis* Thuem. (O); *Coccospora aurantiaca* Wallr. (W); *Coryneum triseptatum* Pk. (W); *Cylindrosporium acerinum* (Pk.) Dearn. & House (O, W); *C. hiemale* Higgins (W); *C. saccharinum* Ell. & Ev. (W); *Dactylium dendroides* Bull. ex Fr. (F); *Darluca Filum* (Biv.) Cast. (F, W); *Fusicladium Robiniae* Shear (W); *Gibellula arenearum* (Schw.) Syd. (F); *G. pulchra* (Sacc.) Cav. (F); *Graphium Hamamelidis* Van Hook (F, W); *Illosporium caespitosum* Ell. & Ev. (W); *Isaria farinosa* (Dicks.) Fr. (F); *Isariopsis clavispora* (Berk. & Curt.) Sacc. (W); *Leptothyrium foraminulatum* Sacc. & Ell. (W); *Macrophoma phacidiella* (Cke. & Ell.) Berl. & Vogl. (W); *Marssonia Populi* (Lib.) Sacc. (W); *Monochaetia camptosperma* (Pk.) Sacc. (W); *M. Desmazierii* Sacc. (W); *Papulaspora candida* Sacc. (W); *Pestalotia macrotricha* Klebh. (F); *Phyllosticta maxima* Ell. & Ev. (W); *P. Nyssae* Cke. (O); *P. smilacina* (Pk.) Dearn. (O); *Pleurocolla compressa* (Ell. & Ev.) Diehl (W); *Polythrincium Trifolii* Kze. (F, W); *Pseudographium hispidulum* (Ell.) Jacz. (F); *Ramularia Oxalidis* Farl. (W); *Sepedonium chrysospermum* (Bull.) Fr. (F, W); *Septoria acerina* Pk. (F); *S. betulicola* Pk. (W); *S. Cacaliae* Ell. & Kellerm. (W); *S. Rubi* Westerd. (F, W); *S. Rubi* var. *pallida* Ell. & Holw. (O); *Sphaeronema pruinosa* Pk. (W); *Sphaeropsis Ellisii* Sacc. (W); *Sporocybe Rhois* (Berk. & Curt.) Sacc. (W); *Sporotrichum Quercuum* (Thuem.) Sacc. (W); *Tubercularia vulgaris* Tode ex Fr. (W).—DAVID H. LINDER.



SARCOSPHAERA CORONARIA

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SARCOSPHAERA CORONARIA

FRED J. SEAVER

(WITH COLORED ILLUSTRATION)

The species named above is one of the larger and most beautiful of the cup-fungi, and while widely distributed it must nevertheless be regarded as one of the rarer forms. The writer has never had the good fortune to encounter it in the field and, while it has frequently been sent in for determination, only once has he had the privilege of seeing the plant in a fresh condition. The name "*coronaria*" refers to the crown-like form of the open apothecia and an appropriate name would be the "Royal cup-fungus."

The colored illustrations accompanying this article were drawn by Miss Fleda Griffith from photographs sent by Miss Elizabeth E. Morse from California, where the plants were collected. The coloring was submitted to her for approval. This constitutes the first report of the species from California.

In the opinion of the writer, *Pustularia gigantea* described by Dr. Rehm of Germany from material sent from Michigan, is identical with the above. Dr. Bessie B. Kanouse, in a recent article in MYCOLOGIA (**33**: 466), regards that species as distinct from the above, and makes it *Sarcosphaera gigantea,* being distinguished by its slightly smaller spores. While there is a chance for a difference of opinion on this point, the writer still believes that the two are identical.

For a complete description and synonymy see North American Cup-fungi, page 235. The colored plate accompanying this article will be issued in a supplemented edition of North American Cup-fungi, now in the course of preparation.

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THE EFFECT OF LIGHT ON TAXONOMIC CHARACTERS IN FUSARIUM

W. C. Snyder and H. N. Hansen

(with 2 figures)

Those who are concerned with the identification and classification of *Fusaria* appreciate the influence that media, temperature, manner of seeding, and other factors in the cultural environment exert on macroscopic features of a fungus in pure culture. Especially important are these environment-induced variations when an attempt is being made to follow a system in which the species lines have been closely drawn, such as in the Wollenweber and Reinking system (8). Recently (6) a species concept has been advocated which calls for a modification of that system. In applying this concept a complete revision of the taxonomy of section *Elegans*, and later of section *Martiella* (7) of the genus *Fusarium*, was proposed. However, regardless of what system is followed, the successful universal use of any system is dependent upon uniform procedures and techniques in the handling of cultures. It is the purpose of this paper to treat one of the several factors which influence the growth of *Fusaria*, namely that of light, and to show the extent to which it affects the taxonomic characters of these fungi. A review of the rather extensive literature on the response of fungi to light will not be attempted here since it has been given elsewhere, in part by Coons (1) and by Harter (3).

EXPERIMENTAL PROCEDURE

Unless otherwise stated, all of the work described herein is based upon single-spore cultures obtained by the method of Hansen and Smith (2). All cultures used in a given experiment were made on the same day, on 2 per cent potato dextrose agar slants having the same preparation history. Five cultures of each fungus were laid horizontally in a single layer in wooden trays which were placed on tables before windows, in such a way as to be well illuminated

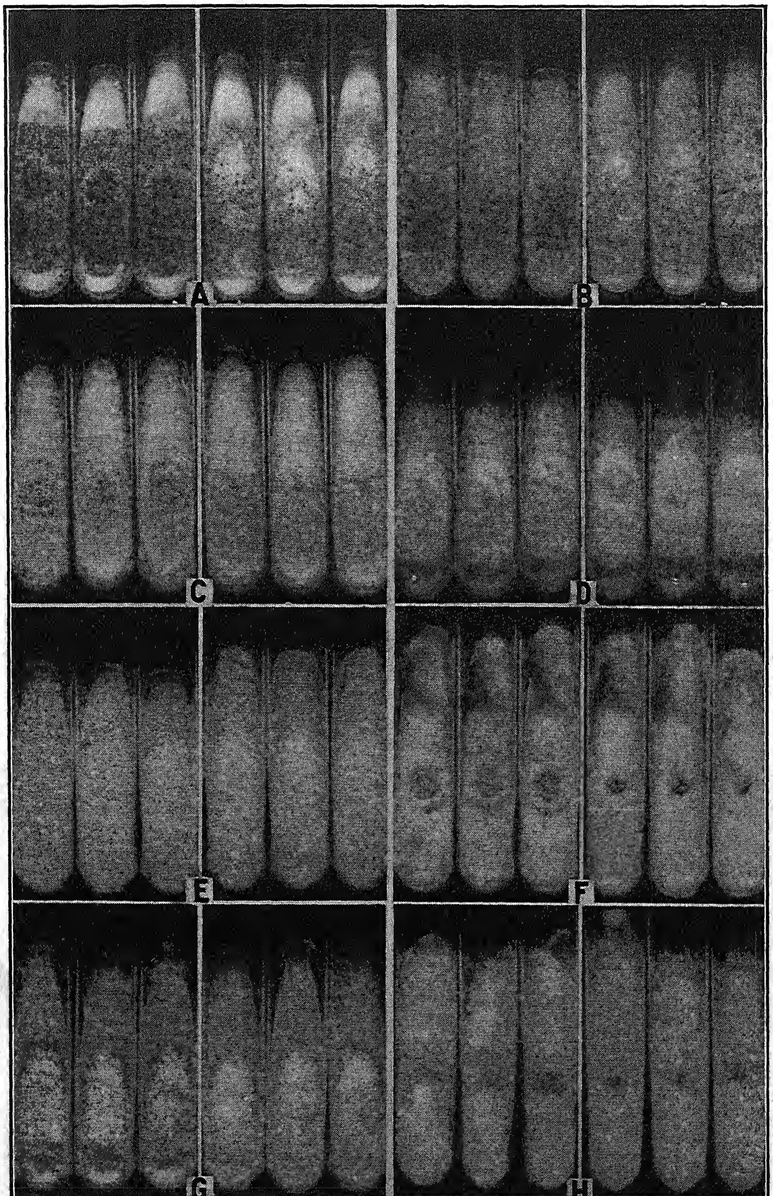

FIG. 1. Cultures of *Fusarium,* in triplicate, photographed after growing for 2 weeks in diurnal light (the left hand trio of each group) and in continuous darkness (the right hand trio of each group). *A–D, F. Solani* f. *Cucurbitae* from squash; *E, F. Solani* from citrus; *F, F. Solani* from sweet potato; *G, F. oxysporum* f. *niveum* from watermelon; *H, F. avenaceum* from carnation.

throughout the day but so as not to receive direct sunlight. Duplicate trays were placed directly beneath those subjected to daylight in a manner which excluded light.

Cultures used in the study included strains of the following fungi, stock cultures of which were grown in the presence of daylight: *Fusarium Solani* (Mart.) App. & Wr. emend. Sny. & Hans., imperfect form of *Hypomyces Solani* Rke. & Berth. emend. Sny. & Hans., and the form of this species pathogenic on cucurbits, namely, *F. Solani* f. *Cucurbitae* Sny. & Hans., of section *Martiella* as recently revised (7). Also used were *F. oxysporum* Schlect. f. *niveum* (E. F. S.) Sny. & Hans., of section *Elegans* (6); and *F. avenaceum* (Fries) Sacc., of section *Roseum.*

RESULTS

Characters in which marked contrasts were observed included: (*a*) pigmentation, (*b*) amount of aerial mycelium, (*c*) zonation, (*d*) amount of sporulation, (*e*) size of conidia, (*f*) septation frequency of conidia, and (*g*) perithecial formation after the fertilization of illuminated and non-illuminated cultures. These were recorded when the cultures were two weeks and again when they were four weeks old. The two readings were so nearly identical that only one set is given here, in table 1. Culture and spore characters are illustrated in figures 1 and 2.

PIGMENTATION

The colors (5) displayed by the fungi recorded in table 1 fell into three general groups on the basis of their relation to light. First, the flesh-ochre and cinnamon-pink pigments developed by *F. oxysporum* f. *niveum* occur only in the presence of light. Second, the ramier-blue which occurs in this same fungus seems to develop equally well in light and in darkness. The same appears to be true for the dusky green-blue of *F. Solani* from tomato, except that in this fungus the pigment is associated with conidial masses and since sporulation is greatly reduced in the absence of light, less of the pigment is observed under this condition. A third type of pigmentation is found in strains D and F of *F. Solani* f. *Cucurbitae* and *F. Solani* respectively, wherein the vetiver-green,

TABLE 1

COMPARATIVE DEVELOPMENT OF SINGLE SPORE CULTURES OF *Fusarium* WHEN GROWN FOR TWO WEEKS IN LIGHT AND DARKNESS

Key to Figs. 1 and 2	Fungus Identity	In Diurnal Light			In Darkness		
		Mycelium	Sporulation	Perithecia *	Mycelium	Sporulation	Perithecia *
A.	*F. Solani* f. *Cucurbitae* from squash	Aerial: moderate olivaceous black, trace white	Sporodochia: moderate, color of mycelium	Abundant	Aerial: moderate dark grayish olive, and white	Sporodochia: scant, color of mycelium	Trace
B.	*F. Solani* f. *Cucurbitae* from squash	Aerial: moderate white and Saccardo's umber	Sporodochia: moderate Saccardo's umber	Abundant	Aerial: moderate white	Sporodochia: scant, tawny-olive	Trace
C.	*F. Solani* f. *Cucurbitae* from squash	Aerial: moderate olive-buff, and white	Sporodochia: abundant, chamois and trace glaucous green	Moderate	Aerial: abundant, white and pale olive-buff	Sporodochia: scant glaucous green, trace chamois	None
D.	*F. Solani* f. *Cucurbitae* from squash	Aerial: moderate pale olive	Scant, no sporodochia nor pionnotes	None	Aerial: abundant citron yellow	Trace, no sporodochia nor pionnotes	None
E.	*F. Solani* from citrus	Aerial: moderate cartridge buff	Pionnotes: moderate, color of mycelium	None	Aerial: moderate, white	Pionnotes: scant, white	None

* After fertilization.
** Not illustrated in figures 1 and 2.

TABLE 1—(*Continued*)

Key to Figs. 1 and 2	Fungus Identity	In Diurnal Light			In Darkness		
		Mycelium	Sporulation	Perithecia *	Mycelium	Sporulation	Perithecia *
F.	*F. Solani* from sweet potato	Aerial: moderate white	Sporodochia: abundant chamois and asphodel green	Abundant	Aerial: abundant, white, strands and patches vetiver green and dark hyssop violet	Sporodochia: scant, only in center, chamois	Trace
**	*F. Solani* from tomato	Aerial: scant white	Sporodochia: abundant, covering slant, dusky green-blue	None	Aerial: moderate, mostly white, sectors violet-slate	Sporodochia: scant, only in center, dusky-green blue	None
G.	*F. oxysporum* f. *niveum* from watermelon	Aerial: scant white and flesh ocher. Plectenchyma: ramier blue	Pionnotes: abundant flesh-ocher	None	Aerial: moderate, white center spot pale olive-buff. Plectenchyma: ramier blue	Pionnotes: moderate, white	None
**	*F. oxysporum* f. *niveum* from watermelon	Aerial: moderate white and pale cinnamon pink. Plectenchyma: white and ramier blue	Sporodochia: abundant, salmon-buff	None	Aerial: moderate, white. Plectenchyma: white and ramier blue	Scant, no sporodochia, not colored	None
H.	*F. avenaceum* from carnation	Aerial: abundant half white, half buff pink. Plectenchyma: pompeian red	Sporodochia: moderate, salmon orange	None	Aerial: abundant Japan rose, trace white. Plectenchyma: pompeian red	Trace occasional sporodochium color of mycelium	None

dark hyssop-violet and citron yellow colors developed much more conspicuously in the absence of light.

MYCELIUM

Although no detailed observations were made on the mycelium itself, the cultures in the dark consistently showed greater mycelial growth than those in the light. Only in cases where the difference was large is this characteristic shown in table 1. The increase in aerial mycelium obtained by growing strain D of *F. Solani* f. *Cucurbitae* in the dark is shown in figure 1, *D*.

ZONATION

All cultures exposed to light developed zonation in some degree whereas none appeared in those grown in the dark. In certain strains of *F. Solani* f. *Cucurbitae,* and *F. Solani* zonation was very pronounced (FIG. 1, *C* and *F*). Some of the cultures in the dark developed sectors of differentiated growth and frequently deep folds in the mat radiated from the centers of the colonies (FIG. 1, *B*). It is recognized that light is only one factor in the environment which may cause zonation.

SPORULATION

Table 1 shows that the sporodochial strain of *F. oxysporum* f. *niveum* produced sporodochia abundantly in the light but not in the dark. In the pionnotal strain, G, of the same fungus, pionotes were produced much more abundantly in light than in the dark. In *F. Solani* and *F. Solani* f. *Cucurbitae,* which sporulate readily under most conditions of culture, the quantities produced in light and in darkness are surprisingly different (FIG. 1, *B* and *F*). The present or absence of sporodochia has been considered an important character in the taxonomy of Fusaria. In *F. avenaceum,* sporulation is plentiful along the edges of the colony in contact with the glass, when grown in light (FIG. 1, *H*), but not when grown in the dark.

The formation of perithecia and mature ascospores of *Hypomyces Solani* depended upon light as did the formation of macroconidia. Perithecial primordia appeared abundantly in the light

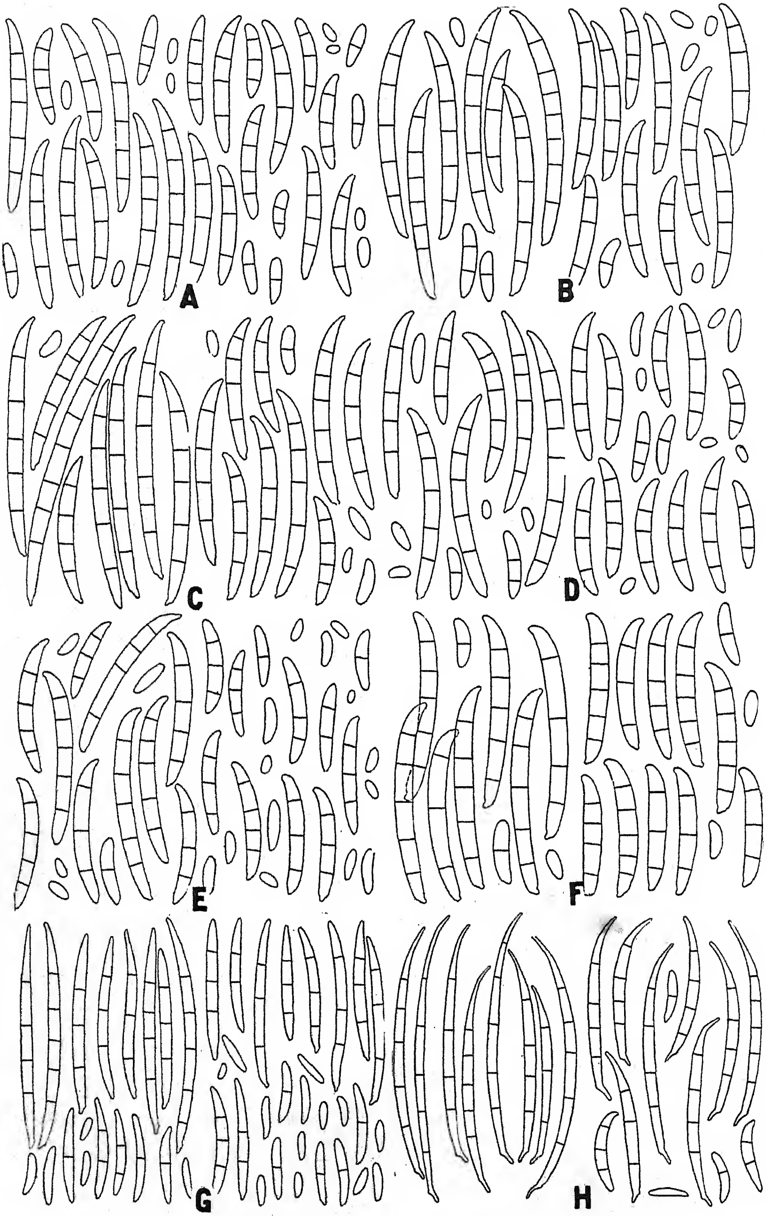

FIG. 2.

after about 2 weeks of growth, while none were apparent in cultures kept in the dark. At the end of a month both the cultures grown in light and in the dark were fertilized with conidia from the opposite sex strain. Two weeks later mature perithecia were abundant on the cultures in the light while those in the dark showed only an occasional immature perithecium or none at all. Not only was light required for the production of perithecial primordia, but it was also found that the development of these primordia into mature perithecia was favored by their continued exposure to light.

SIZE AND SEPTATION OF CONIDIA

In figure 2 is illustrated the relative size and the relative amount of septation of conidia produced on illuminated and on non-illuminated cultures. All drawings were made at the same magnification, at the same time. Samples of spores were always taken from that portion of the thallus in which the largest amount of sporulation occurred. It will be noted that those produced in light were consistently larger, and had more septa, in all cases. The relative differences in these cultures remained the same after two, four and six weeks. Since Harter's paper (3) dealt primarily with the influence of light on size and septation, no further attention need be given to them here, other than to call attention to the fact that they have been considered important in classification.

LOCALIZATION OF LIGHT EFFECT IN THE THALLUS

Two trays, each containing 40 single spore cultures of *F. Solani* from sweet potato were prepared and placed before a window, one tray covering the other. Every day at 5 P.M., 4 cultures which had grown in the light were exchanged with 4 that had been in the dark since initiation of the experiment. At the end of 10 days the surface of the cultures kept in the light the full 10 days were

FIG. 2. Camera lucida drawings made at the same magnification, of conidia produced by the *Fusarium* cultures illustrated in figure 1. Those on the left, in each case, were taken from cultures grown in light; those on the right, from cultures grown in the dark. *A–D, F. Solani* f. *Cucurbitae* from squash; *E, F. Solani* from citrus; *F, F. Solani* from sweet potato; *G, F. oxysporum* f. *niveum* from watermelon; *H, F. avenaceum* from carnation.

practically covered with a sheet of macroconidia, whereas those which had remained in the dark during this time were entirely mycelial except for a small conidial mass at the point of inoculation. Forming a perfectly intergrading series were the cultures which by daily exchange had accumulated in the light tray. The longer the cultures had remained in dark before being transferred to light, the larger was the area of the mycelial part of the colony and the narrower the sporulating zone beyond it. In less than 10 days the fungus had covered the surfaces of the slants, and thereafter little or no benefit in respect to sporulation was obtained by bringing cultures from the dark into the light. Conversely, in the tray kept in darkness, the longer the period in which the fungus had been exposed to light before being placed in the dark, the larger was the area of the colony which was covered with spores and the narrower was the zone of mycelial growth which surrounded it.

These results suggest that the effect of light in stimulating conidium formation is rather localized in that part of the thallus which is growing at the time of exposure to light. The examination of growing cultures which have been brought into light after having started their development in the dark, indicates that the production of normal conidia is initiated in *F. Solani* within 24 hours after having been placed in the light, and that the zone affected is that which forms, or continues its development, after exposure to light.

DISCUSSION

The data presented in table 1, and in figures 1 and 2, show that striking temporary variations occur in the colony characters of color, zonation, amount of mycelium, amount of sporulation, and cultural topography, depending upon whether the cultures are grown in light or darkness. Furthermore, appreciable differences were obtained in the taxonomically more important characters of size, shape, septation and manner of formation of the macroconidia, between cultures of the same fungus grown in light, and in dark. These characters, especially, carry much weight in the system of Wollenweber and Reinking. The findings confirm, and supplement, those of Harter (3, 4) whose work was limited to fewer fungi and fewer characters.

However, the writers' observations are in contradiction to Harter's implication that *Fusarium* cultures need be exposed to light only during the first 4 days after they are made, in order to develop similarly to those allowed to remain in light during the entire growth period. In the experiment on the localized effect of light, it is shown that the normal production of conidia, and of other light-induced effects, occur principally in those zones of growth which are initiated, or in which development is continued during exposure to light. Harter's contention that the first 4 days determine the light effect on a fungus in culture, holds true where the smear method of seeding slants, which he used is employed. The explanation of this difference between single spore and smear cultures would seem to lie in the fact that in smear cultures a multitude of local foci of growth over the entire slant causes mycelial development to be practically completed in 4 days, whereas in the single spore seeding the thallus develops continuously from a single focus for about 10 days before it covers the same area of slant surface and completes its mycelial development. The same difference may occur in a slightly smaller degree between smear cultures and those prepared in the usual manner of transferring a small mass of fungus hyphae with or without its supporting medium.

The single spore method used here has an advantage over other transfer methods in that it permits a more detailed analysis of the differences induced by the modification of an element in the environment. It reveals such characters as zonation and pigmentation in a way impossible with the smear method. The differences between the ratios of 3-, 4-, and 5-septate spores that Harter (4) found in individual tubes perhaps may also be traceable to his method of seeding. Certainly it may not become immediately apparent by such a method when variants appear in the stock culture. In the work reported here, no differences in septation ratios or in any other spore character were found between the individual single spore cultures of a stabilized homotypic clone when grown in the same environment.

The importance of light in the inception of perithecial primordia and in the development of perithecia following fertilization is

shown to be marked in *Hypomyces*. The implications of this finding, in respect to the development and location of perithecia of such fungi in nature and in the laboratory, are apparent.

It becomes clear that it is essential where *Fusaria*, or other similar fungi are concerned that the cultures be allowed to develop in the presence of light, if the maximum development of colony and of morphologic characters employed in taxonomy is desired; and that the same considerations apply to the perfect stages of these and probably of many other fungi.

SUMMARY

Marked differences in the characters ordinarily used in taxonomy are revealed when 10 strains of 3 species (*F. Solani, F. oxysporum* and *F. avenaceum*), representing 3 sections of the genus *Fusarium*, are grown in light, and in darkness.

The quality of the colony and morphologic characters were affected, as were also the quantity and to a certain degree the occurrence of such characters as perithecial primordia.

Evidence is given which indicates that the effect of light is produced on that portion of the thallus which is actively growing at the time of exposure. Single spore cultures subjected to light only for the first 4 days of growth, fail to develop in the same manner as those allowed to remain in light.

It is concluded that such characters as color, zonation, type of colony, presence or absence of sporodochia; size, shape and septation of macroconidia; and even the occurrence of a perithecial stage, can not be employed successfully in taxonomy unless these fungi are grown in adequate light.

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COMPARATIVE STUDIES ON THE PRIMARY AND SECONDARY ZOÖSPORES OF THE SAPROLEGNIACEAE. I. INFLUENCE OF TEMPERATURE [1]

S. B. SALVIN [2]

(WITH 2 FIGURES)

INTRODUCTION

Optimum and other conditions for zoöspore production have been investigated by Cotner (1), Jones and Drechsler (5), de Bary (3), and others. No one, however, has published a comparative analysis of the physiological properties of primary versus secondary zoöspores, using the rate of movement as an index. Such properties would include the reactions of the swarmspores to various temperatures, viscosities, hydrogen-ion concentrations, salinities, and degrees of aerobiosis. The present study deals chiefly with one of these properties—namely, the effect of temperature on the zoöspore activity. In a later publication, the author hopes to describe the influence of the other conditions on both primary and secondary zoöspore activity.

MATERIALS AND METHODS

Five members of the Saprolegniaceae were used in the following work: *Saprolegnia delica* Coker, isolated from Houghton's Pond in the Blue Hills Reservation of eastern Massachusetts; *Saprolegnia* W, a non-sexual form obtained from sand at the edge of Walden Pond, Concord, Mass.; *Achlya flagellata* Coker, collected from Beaver Brook, Waverly, Mass.; *Thraustotheca clavata* (de Bary) Humphrey, isolated from sludge from Ithaca, N. Y.; and

[1] Contribution from the Laboratories of Cryptogamic Botany and the Farlow Herbarium, Harvard University, no. *190*.

[2] The writer expresses his gratitude to Prof. W. H. Weston, under whose guidance this investigation was conducted, for his valuable suggestions and continued interest.

Dictyuchus 2, another non-sexual form, obtained from an infected *Avena* seed submerged in a hay infusion medium for protozoa.

All cultures used were grown from single-spore inoculations, and all experiments carried out in sterile, redistilled, well-aerated water. The sporangia and zoöspores were taken from young, vigorous mycelia, 24 to 48 hours old, which had been grown at temperatures approximating 25° C. At the time of the experiment, a mature sporangium, ready to discharge its spores, was cut free from the mycelial mass and carefully transferred, with a small portion of the attached hypha, to a hanging-drop which had already attained the required temperature.

The experiments were conducted in rooms the temperatures of which were 5°–10° C. below those of the micro-stage constant temperature chambers (manufactured by the Chicago Chemical and Surgical Company), in which the zoöspore preparations were enclosed.

After the hanging-drop slide with the sporangium enclosed had been inserted in the micro-stage, a half-hour was allowed to elapse before any readings were taken in order to make certain that equilibrium had been attained within the apparatus. After this interval and after the emergence of the zoöspores, the time required for the swarmspore to swim across the field of the microscope was determined by means of a stop-watch. Only those times were recorded in which the zoöspore moved in a reasonably straight line and through a diameter of the field. If the spore spiraled or twisted excessively or if it swam along a chord of the field, the reading was rejected. In this way, fairly consistent results were obtained. For example, when three sets of readings were chosen at random, the close agreement of the figures was obvious, as substantiated by the values of the mean, median, mode, and standard deviation (TABLE 1).

The actual rate of movement of the zoöspores was obtained by dividing the diameter of the microscope field (0.33 mm.) by the time required for the spore to traverse this distance.

RESULTS

For understanding the activity of the zoöspores, it is well to review briefly the structure and method of swimming of the two

TABLE 1

TO SHOW AGREEMENT IN THE RATES OF ZOÖSPORE MOVEMENT IN 60 READINGS OF EACH OF THREE SETS OF DATA

Genus and Condition	Range	Mean	Median	Mode	Standard Deviation
Dictyuchus 2 at 15° C. 60 readings........	2.5–2.9 sec.	2.69 sec.	2.7 sec.	2.7 sec.	0.0855
Saprolegnia W at 10° C. 60 readings........	2.2–3.0 sec.	2.56 sec.	2.5 sec.	2.5 sec.	0.672
Dictyuchus 2 at 30° C. 60 readings........	1.2–1.5 sec.	1.33 sec.	1.3 sec.	1.3 sec.	0.086

types. The primary zoöspore of *Saprolegnia* normally emerges through the papilla of the sporangium as a motile, pip-shaped entity with two anteriorly attached flagella, each of the same length and slightly longer than the body of the zoöspore proper. Each of these two flagella is inserted in a highly staining granule, situated at the apical end of the anteriorly located nucleus. The cytoplasm of the swarmspore is differentiated into two parts: a central, dense mass, enclosing most of the nucleus; and a vacuolar, less dense peripheral zone (1).

The secondary zoöspore of *Achlya, Saprolegnia, Dictyuchus,* or *Thraustotheca* emerges from its cyst as a subovoid body with two rather long flagella—both inserted laterally, with one extending anteriorly and the other posteriorly. By means of a basal granule, each of the flagella is associated with the nucleus, which is centrally located and surrounded by a rather dense mass of cytoplasm. The rest of the zoöspore body consists of vacuolar, less dense cytoplasm. In its swimming movements, the primary zoöspore was observed traveling in an irregular spiral course, with a rotation usually in a counter-clockwise direction—in contrast to the secondary in which the rotation was generally clockwise.

The primary zoöspores, discharged from the sporangia of *Saprolegnia* W and *S. delica,* differed from the secondary, obtained from *Achlya flagellata, Thraustotheca clavata, Dictyuchus* 2, and *Saprolegnia* W, in such characters as the rate of movement, the length of the swarming period, and the reaction to various temperatures. When the two types of zoöspores were subjected to a temperature of 25° C. (77° F.), the secondary zoöspore progressed at a more

rapid rate, with the primary averaging 110 μ per second, and the secondary of *Saprolegnia, Achlya,* and *Dictyuchus,* 236, 195, and 201 μ per second respectively.

In the length of the swarming period, the two types of zoöspores differed, with the primary swarming on an average from 12 to 35 minutes and the secondary from 25 to about 450 minutes. In one instance, the total swarming period of the zoöspores of the non-sexual *Dictyuchus* was strikingly long, having been observed for over eight hours, at the end of which time the writer had to discontinue the observations; yet, almost all of the zoöspores were still swarming and there were no empty cysts in the hanging-drop to indicate that any repeated emergence had begun.

The primary and secondary zoöspore rates were studied and compared over a range from 10° C. (50° F.) to 30° C. (86° F.) (FIG. 1). The secondary typically carried on normal activity over wider extremes of temperature; swarmed at a faster rate and for

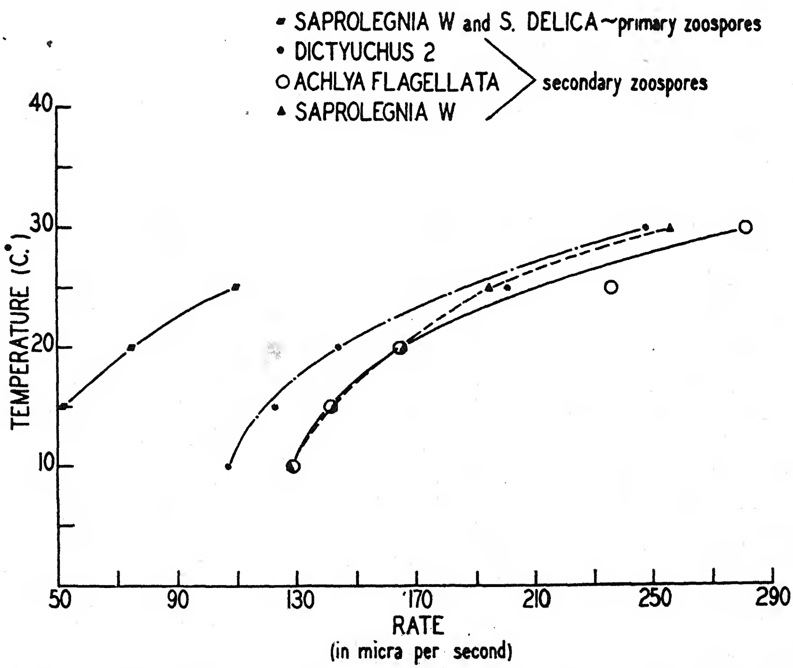

FIG. 1. Graph, illustrating the influence of temperature on the movements of primary and secondary zoöspores.

a longer period; almost trebled its speed over the range of normal activity; had its slowest rate equaling the fastest for the primary; was less inclined to gyrations; had its speed range from 170 μ per second at 10° C. to 282 μ per second at 30° C.; possessed an average "temperature coefficient" (Q_{10}) of 1.36 to 1.66 at the temperatures 15° to 25° C.; and had a Q_{10} extend in *Saprolegnia* from $1.28_{(10°-20°)}$ to $1.71_{(20°-30°)}$, in *Achlya* from $1.30_{(10°-20°)}$ to $1.58_{(20°-30°)}$, and in *Dictyuchus* from $1.36_{(10°-20°)}$ to $1.71_{(20°-30°)}$. The primary, on the contrary, displayed normal activity over a narrower temperature range; swarmed at a slower speed and for a shorter time; hardly doubled its rate over the range of normal activity; carried on more gyrate movements; had a speed extending from 57 μ per second at 15° C. to 110 μ per second at 25° C.; and was characterized by a Q_{10} of 1.93 at the temperatures of 15° C. to 25° C.

In addition to the general conclusions mentioned, certain specific observations at the extremes of the temperature range are of interest. At 10° C., the primary zoöspores of *Saprolegnia* did not behave in a normal manner after their emergence from the sporangium. In some instances, when they encysted almost immediately after emerging, they all formed a loose mass of encysted spores near the mouth of the sporangium. In others, some of the primary zoöspores encysted almost at once, and the rest whirled about in very narrow spirals; whereas in still others, some of the zoöspores wiggled within a quite limited area and the others rotated their anterior ends slowly while the posterior remained stationary.

At 30° C., primary zoöspore activity was also abnormal. Instead of swimming in a relatively straight line, the zoöspores circled and spiraled, twisted and turned, and carried on vigorous vibratory movements. In addition, on two separate occasions, fusion of zoöspores was observed—a phenomenon never previously recorded in the literature. As two zoöspores circled near each other, their anterior portions accidently came into contact and then became attached apparently quite firmly. Although it was quite difficult to observe exactly what happened during the subsequent two to three minutes due to the intense and irregular whirling motion of the zoöspores, it was noted that the two bodies slowly fused, after

which activity suddenly ceased. About a half-hour later, the resulting cyst gave rise to a short hypha of germination.

When attempts were made to study the movement of secondary zoöspores of *Saprolegnia* W and *Dictyuchus* 2 at 35° C. (95° F.), no results were obtained for two main reasons: first, the encysted spores, whether within or without the sporangium, mostly failed to give rise to motile entities, but germinated *in situ* by giving rise to a short hypha; secondly, in the very few cases where secondary zoöspores were emitted, the path of motion was so irregular as to make the recording of accurate results impossible.

DISCUSSION

It is known that many vital processes in both plants and animals are accelerated by a rise in temperature. This relation between the velocity of a reaction and the temperature may be expressed by the ratio,

$$\frac{K_{t^\circ}}{K_{t^\circ-10}},$$

in which "K" indicates the frequency of a process at each of two temperatures 10° C. apart. This ratio, known as the "temperature coefficient," or Q_{10}, has a value of from 1.2 to 1.5 for certain physical processes, such as vaporization, and from 2 to 3 for many chemical reactions.

However, the use of the "temperature coefficient" does not permit analysis of frequent alterations of rate with change in temperature. Hence, there has arisen the use of the "temperature characteristic," μ, as applied to the Arrhenius equation:

$$\frac{K_2}{K_1} = e^{\frac{\mu}{R}\left(\frac{1}{T_1}-\frac{1}{T_2}\right)},$$

where K_1 and K_2 are the velocity constants at temperatures T_1 and T_2, e is the base of the natural or Naperian logarithm (2.718), R is the gas constant, and μ is the "thermal increment" or "temperature characteristic" (2).

Although it has originally been suggested that the "temperature characteristic" depended on the formation of active molecules of a reaction, the investigations of Rice (6) gave adequate basis for

the belief that the controlling factor was the rate of activation of the catalyst in the process. Thus, for those reactions known to be catalyzed by the hydrogen ion, μ has a value of 20,000 calories; by iron, 16,200; by the hydroxyl ion, 11,500; and by copper, 8,000.

The velocity of a vital reaction is assumed to be controlled by the velocities of closely associated systems of chemical reactions, with the slowest portion of the chain determining the speed of the process as a whole. As Crozier (2) has so aptly stated, "the virtual velocities of two catenary reactions

$$A \underset{k_1}{\longrightarrow} B \underset{k_2}{\longrightarrow} C$$

with velocity coefficients k_1 and k_2, and having different temperature characteristics, might be so related that at a certain temperature these actual velocities are dynamically identical, while below that temperature $A \rightarrow B$ would be the 'slow reaction,' and above that temperature $B \rightarrow C$."

In the analysis of the data concerning the swimming movements of the primary and secondary zoöspores of the Saprolegniaceae, it is assumed that the forward progress depends on a chain of chemical reactions, and that the same amount of energy is expended in the traversal of a given distance. Hence, in its relations to temperature, the swimming movements of the zoöspores should reflect the properties typical of the controlling process.

The "temperature characteristics" (μ) for the primary zoöspores and for the secondary zoöspores were found to be 10,450 and 8,100 respectively (FIG. 2), remaining constant throughout at the temperatures from 15° to 25° C., and from 10° to 30° C. respectively. In addition, the secondary zoöspore with its faster rate of movement probably has a higher rate of oxygen intake than the primary, since Gray (4) showed that in *Mytilus* the rate of ciliary movement was proportional to the oxygen consumption.

At this point, an attempt might be made to identify the reactions the rates of acceleration of which are characterized by μ values of 10,450 and 8,100. The magnitude of the former value would indicate that the controlling reaction might fall within the class of processes catalyzed by the hydroxyl ion, whereas that of the latter would suggest that the reaction was under the control

of a copper catalyst. The foregoing values also suggest, first, that the dominant and limiting process in the secondary zoöspore is identical in all the genera studied, and secondly, that even within a single species, as soon as there is a transition of the zoöspore from a primary to a secondary type, not only is there a change in the general morphology, but in reality a transformation in the fundamental biochemical constitution.

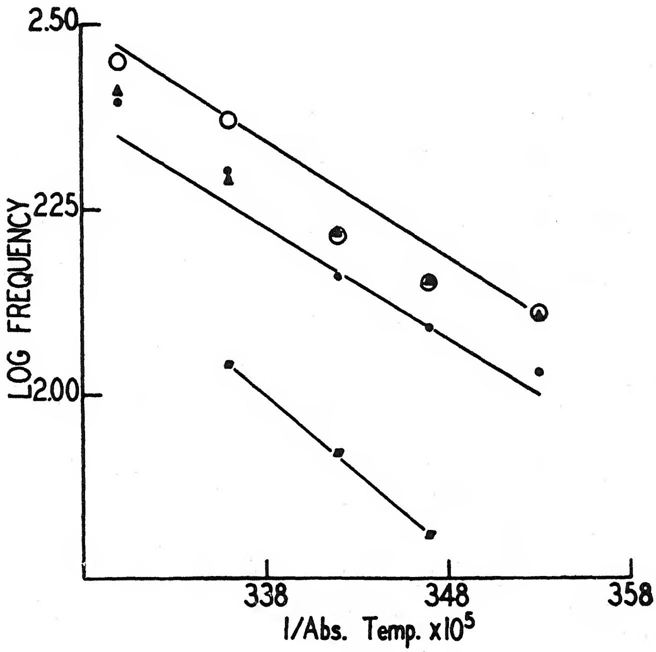

FIG. 2. Graph, illustrating the temperature characteristics for the frequency of zoöspore movements. (Legend is the same as in Fig. 1.)

From the previously described experiments, it becomes evident that the secondary zoöspores are by far the more efficient in the survival and distribution of the fungus because they are more resistant to temperature changes and extremes; and swarm more readily, at a faster rate, and over a greater period of time. Furthermore, they are capable of carrying on repeated emergence (7).

SUMMARY

The activity of the primary and secondary zoöspores in four genera of the Saprolegniaceae was studied and compared at tem-

peratures from 5° to 35° C. Under carefully controlled conditions, primary zoöspores, for example, swarmed for a shorter period, carried on normal activity over a narrower temperature range, moved at a slower rate, and had a higher temperature coefficient than the secondary. Since the two types have different "temperature characteristics," their activities are probably controlled by different catalysts.

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STAGES IN THE DEVELOPMENT OF THELOTREMA INTERPOSITUM

G. T. Johnson [1] and W. L. Brown [2]

(with 9 figures)

INTRODUCTION

Thelotrema is the type genus of a family of discomycetous lichens which, though widely distributed throughout the world, occurs primarily in tropical and subtropical regions. With the exception of a few remarks by Redinger (**1936**), based upon work with herbarium material, no developmental study of the genus has appeared to date. Material of *Thelotrema interpositum* (Nyl.) Müll. Arg. was obtained near Perkinston, Stone County, Mississippi, in December, 1938, June, 1939, and August, 1940 (killed and fixed in formol-acetic-alcohol and in Navashin's solution). Permanent slides, prepared after embedding this in low-viscosity nitrocellulose by the method described by Koneff and Lyons (**1937**), were supplemented by smears prepared in the field. Examination of this material has enabled the writers to ascertain stages in the development of the species which seem to be of sufficient interest to justify their description and illustration at this time.

STAGES IN DEVELOPMENT

Crustose lichens usually have very simple thalline structure. Those like *Thelotrema,* which occur primarily on the bark of living trees, are often more or less immersed in the substrate. Hyphae of *T. interpositum* penetrate several cell-layers into the bark, but the evident portion of the thallus is superficial (fig. 3). The superficial tissue is arranged in a pustule-like manner, in which the algae are located near the outside, forming a layer above some small air cavities and surrounded by the fungal component. Apothecial

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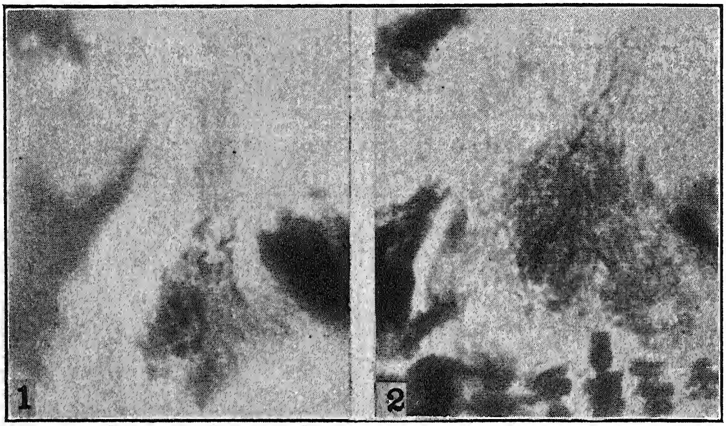
initials arise below the gonidial layer, just above the uppermost layer of bark cells. Primordia have been found in all of our collections and they may apparently be present at all periods of the year.

The primordial coil of hyphae expands and ascogonia are developed. Throughout this and subsequent processes, the initial gradually becomes embedded in and somewhat surrounded by bark cells (FIGS. 2 and 3). All apothecia arise from initials containing



FIGS. 1 and 2. Apothecial initials destained sufficiently to show the ascogonial coils. × approx. 440.

several ascogonia (FIGS. 1–5) and each ascogonium is composed of a coil of large, dark-staining, uninucleate cells (FIGS. 1 and 2). A trichogyne, an elongate series of uninucleate cells, is formed which extends from the coil to a considerable distance above the thallus (FIGS. 4 and 5). The trichogyne may vary from 60 to 112 μ in length and project as much as 39 μ above the surface of the bark.

Examination of the slides prepared by smear technique revealed that some of the apothecia were of more than usual interest. The apothecia in question were evidently younger than others, judged by size and shape, but there were no other evident morphological differences. In many of these neither asci nor spores could be found, but numerous small bodies, similar in appearance to certain types of spermatia were observed (FIGS. 6–9). These were borne on the structures that in older apothecia would unhesitatingly have

been called paraphyses. Each "paraphysis" was filamentous and composed of uninucleate cells. The spermatium-like bodies developed on the "paraphyses" in the manner shown by figure 7. They were borne laterally on the filaments, and though several were usu-

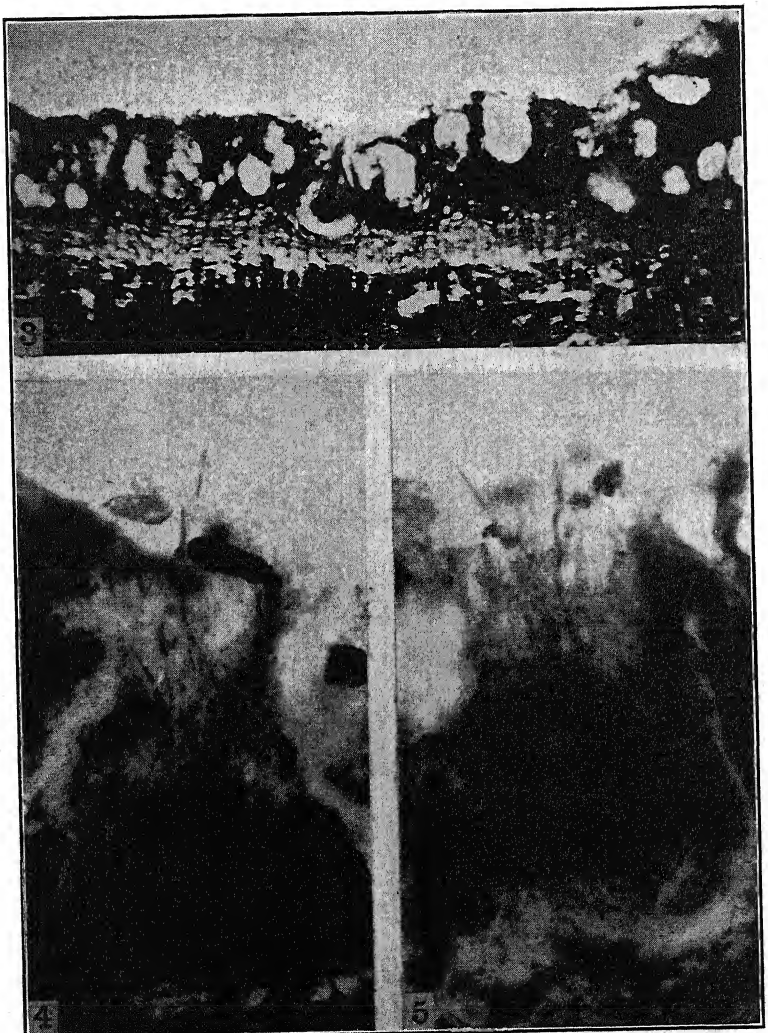


FIG. 3. A section of the thallus illustrating the location of the apothecial initial in relation to the substrate. × approx. 100. FIGS. 4 and 5. Apothecial initials stained so as to show the trichogynes projecting above the surface of the thallus. × approx. 440.

ally found on a single filament (FIGS. 7 and 9), we never observed more than one attached to a single cell. When the bodies were mature they contained only one nucleus and the cells upon which they were borne were also uninucleate. They were hyaline, 3 to 7 μ in length, and fusiform to ovoid or bacilliform. We feel certain that they were produced within apothecia in all cases, because we have observed them in apothecia within which mature spores were also borne. The "paraphyses" could easily be traced into the layer of ascogenous hyphae, but it was not possible to determine if the two were connected.

Few stages intermediate between primordia provided with trichogynes and mature apothecia have been found. The spermatium-like bodies have been seen in the neighborhood of trichogynes, but not in actual connection with them. Whether or not spermatia fuse with trichogynes, the latter soon degenerate and a complex system of ascogenous hyphae is formed. Asci apparently arise from this through typical croziers. The young ascus is uninucleate from an early stage.

The asci of *T. interpositum* are greatly elongated and devoid of a conspicuous sheathing membrane in their younger stages. In many other lichens the asci are more clavate, and the sheathing membrane is more distinctly visible, even in young asci, particularly in the nature of a thickened tip.

Dodge (1928) has described spore formation in asci with fewer than eight spores. In these cases the definitive nucleus divides three times. Eight nuclei result, one of which functions in the formation of the spore while the rest degenerate. *T. interpositum* is interesting both because the ascus is one-spored and because the spore is muriform. Division of the fusion nucleus takes place and eight nuclei are probably formed. A thick membrane is secreted around one of these. The membrane is very distinct, but it surrounds only a small portion of the epiplasm of the ascus. Two or more spore initials may be found, but asci containing these probably do not develop since only one mature spore per ascus has been observed. A great deal of deeply staining chromatin-like material is present in the asci. This may represent decomposed nuclei, but further evidence is required, since even young asci contain a substance which stains in a similar manner. The young spore and

its membrane increase in size until the interior of the ascus is well-filled.

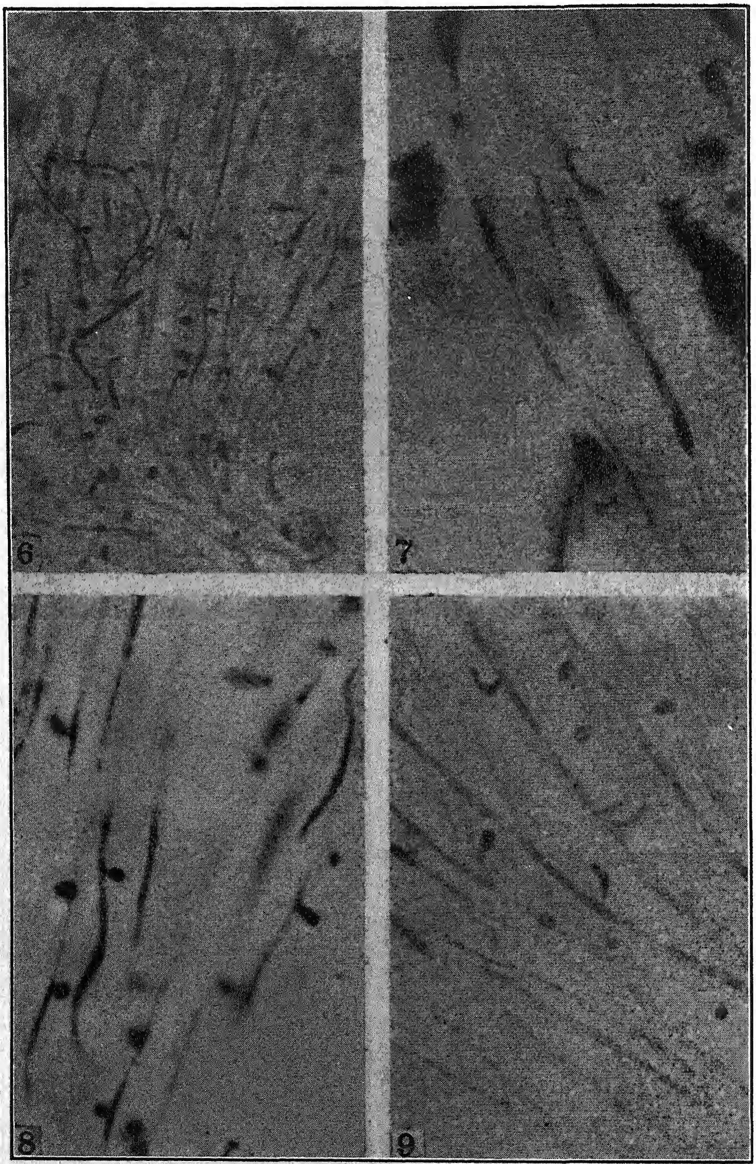
DISCUSSION

The discovery of spermatium-like bodies attached to "paraphyses" is the most important contribution reported in this paper. To the writers' knowledge, no structures exactly like these have previously been described for any lichen. Technical difficulties are encountered in the study of lichen life-histories, and far too little is known about developmental stages, even in connection with the species that have been studied in the greatest possible detail. The use of smear techniques (Johnson and Brown, 1941) resulted in the discovery of these unusual structures in *Thelotrema,* and we have found such methods the most convenient for their study. The bodies are probably asexual spores or elements which have some function in a sexual process.

Asexual spores are rare among lichens. Those reported by Bornet (1873) for *Arnoldia* (*Physma*) *minutula* are quite different from the structures we have described (Miss Smith, 1921, noted that Bornet might have had a parasitic imperfect fungus). In *Caloplaca aurantia* var. *callopisma* Steiner (1901) described conidia similar to the structures in *T. interpositum* in that the conidia were borne within apothecia and even within those containing asci and spores. In *T. interpositum,* however, several bodies are produced laterally rather than a single one terminally, and the apothecia in which they are borne are normal rather than abnormal in appearance. In *C. aurantia* var. *callopisma* the conidiophore increased in length during the production of the conidium and the spore was finally borne above the disk when it was mature. In contrast, *T. interpositum* produces its bodies within the apothecium (at maturity they are found free within it), the apothecium is not open and disk-like as in *Caloplaca,* and no mechanism for the dissemination of an asexual spore is evident.

One should bear in mind that the differences between conidia and spermatia sometimes seem very slight, as work on *Neurospora* (Dodge, 1932; Backus, 1939) has clearly shown.

The strongest evidence yet available that spermatia in other lichens function in a sexual process comes from observations re-



FIGS. 6–9. From acetocarmine smear preparations. FIG. 6, spermatium-like bodies attached to 'paraphyses,' × approx. 440; 7, spermatium-like bodies in young stage of development; 8 and 9, spermatium-like bodies near maturity. FIGS. 7–9, × approx. 900.

porting the close attachment of spermatia to trichogynes. We have found bodies similar to those borne in the young apothecia near trichogynes of *Thelotrema,* but have never seen the two in organic union. There is some evidence that these spermatium-like bodies are similar to spermatia in function, but further data is necessary to determine the validity of the supposition.

A single case is known, however, which adds considerable weight to such an opinion. In *Collemodes Bachmanianum* (Bachmann, 1912, 1913; Fink, 1918) spermatia are not found enclosed in spermagonia, but both terminal and lateral spermatial groups are borne on spermatiophores embedded within the thallus. The characteristics of these undoubted spermatia are sufficiently similar to those of the spermatium-like bodies of *T. interpositum* to indicate that the structures may be homologous.

It has been suggested that copulation may occur between these elements, but neither this reaction nor any evidence to support the suggestion has been observed. The writers are aware that paraphyses are reported to cut off conidium-like formations from their tips (*e.g.,* Schmidt, 1939) and that ladder-like cross-connections are sometimes formed between paraphyses, but there seems no similarity between either of these and the bodies we are inclined to consider spermatia. Regardless of the interpretation now placed on these structures, however, their discovery is somewhat startling, and it has resulted in sufficient evidence to indicate that the description of the complete life-history of this lichen will be of considerable interest to morphologists.

SUMMARY

1. The apothecia of *Thelotrema interpositum* arise from a group of ascogonial coils, each of which is provided with a trichogyne. This initial is similar to that which has been described in many lichen groups.

2. Spermatium-like bodies have been found attached to the "paraphyses" of some of the apothecia. These are unusual in their nature and place of occurrence, but they seem best interpreted either as asexual spores or (more probably) as spermatia. There is some evidence that they may fuse with the trichogyne.

3. Asci are formed from ascogenous hyphae, apparently through typical croziers. The asci first grow in length and the sheathing membrane may not appear until a later stage. After division of the definitive nucleus, one of the resulting nuclei is delimited in a small unit of the epiplasm by a very distinct membrane and this spore initial grows to fill the ascus. Most asci contain some puzzling chromatin-like material.

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PODAXIS PISTILLARIS. II

Elizabeth Eaton Morse

A former paper on *Podaxis* [1] by the writer concluded with the hope that the relationships of this genus would yet be fully worked out. This hope is in course of realization. Very young material from the Colorado Desert was supplied by E. V. C. Northrop, El Centro, Calif., to both Fischer and Brasfield who agreed that very early stages of *Podaxis* and *Secotium* [2] are similar. Brasfield found that in *Seçotium* the hymenium consists of closely compacted basidia which cover the surface of crumpled gills, whereas the writer found in *Podaxis* that the gleba develops into capillitium, basidia, and variable spores, with no suggestion of lamellae; furthermore, *Secotium* has no capillitium.

The classifications of *Podaxis* and *Secotium* made by Brasfield and Fisher are quite different; the former places them together in Secotiaceae in Hymenogastrales. In Die Natürlichen Pflanzenfamilien, Vol. 7a, 1933, Fischer makes a separate " Unterreihe " for *Podaxis*—Podaxineae—to include two families in equal rank, Podaxaceae and Secotiaceae—*Podaxis* being the sole representative in its family. The writer favors Fischer's disposition of this genus.

The powdery gleba of *Podaxis* at maturity points to relationship with Lycoperdaceae proposed by Lloyd and accepted by Clements and Shear.

The phylogenetic position of *Podaxis* still remains in doubt, as in the time of de Bary (1887), although some progress has been made towards its determination.

There are other stalked gasteromycetes produced in sandy regions, namely, *Phellorinia* (which also has fascicled basidia like *Podaxis*), *Gyrophragmium, Montagnites, Batarrea, Tulostoma, Calostoma* and *Dictyocephalos,* whose respective relationships to *Podaxis* and to one another are not yet determined.

Specimens of *Podaxis* collected by W. H. Long from alkaline or salty soil in Brownsville, Texas, Nov. 1916, appeared to be identi-

[1] Mycologia **25**: 1–33, 1933.

[2] Univ. of Iowa Studies **17**: 200–206, 1937.

cal with those collected in other regions in the southwest except that the spores are uniformly smaller, averaging only $3–7 \times 3–5.25\ \mu$ instead of $8.5–19 \times 8.5–15\ \mu$ (Long Herbarium, Albuquerque, N. M., *6884*). Carleton Rea studied the material from Doctor Long and reported that "it is a small-spored race of *Podaxis*." Heim, in "La formation des spores chez les *Podaxon*" (1932), states that spores may exhibit great variation in form and size, probably correlated with nutritional or other environmental factors. Possibly we should be prepared to accept even marked variation in spore size according to favorable or unfavorable conditions of moisture, temperature, soil or salinity; however, the writer would designate the above mentioned Texas material as a variation of *Podaxis pistillaris* (L. ex Pers.) Fries **paurospora** var. nov. Dearn., a name suggested by Dr. Dearness.

We are grateful to J. B. Cleland for specimens collected in Australia which he called *P. loandensis.* These have been examined by Lee Bonar, V. M. Miller and the writer without finding any specific differences from our *Podaxis pistillaris*; so far it still appears to the writer that probably there is only one variable species of *Podaxis*.

Podaxis pistillaris was found near Gardner Bay, Hood Island, Galapagos, "on the equator," by Stewart, June 26, 1906, communicated by Alice Eastwood and John Howell, Academy of Sciences, San Francisco, No. *7532,* recorded by Bonar in Proc. Calif. Acad. Sci., July 20, 1939.

The northern range of *Podaxis,* 40° N. Lat., was extended by about 100 miles when S. M. Zeller discovered a specimen in a strawberry patch at Bend, Oregon, June, 1935.

The species is widely distributed in California, Arizona, Nevada, New Mexico and Texas—we have had many new collectors and additional localities represented since 1933. Furthermore, there are records which show that *Podaxis* has been collected from the Sinaitic peninsula in Asia, from termite mounds in Madagascar and South Africa, in fact from every continent.

Further reports are solicited, especially of the new small-spored variety, *paurospora.*

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CORDYCEPS STYLOPHORA AND CORDYCEPS RAVENELII [1]

E. B. Mains

(with 2 figures)

Cordyceps stylophora was collected by Ravenel in South Carolina and was described and illustrated by Berkeley in 1857 (1). Ravenel distributed it in his Fungi Car. V: 49. It has been rarely collected. It was next obtained by G. H. Hicks in April 1892 near the Michigan Agricultural College at East Lansing, Michigan. A part of this collection is in the Herbarium of the University of Michigan and bears a notation that it was determined by Ellis. Longyear (3) reported it in 1904. Roland Thaxter collected a specimen in August 1896 at Burbank, Tennessee (4). Petch (7) has reported a collection (Cornell *14808*) by H. H. Whetzel from Cayuga Lake Basin, New York, made in November 1902. L. E. Wehmeyer obtained two specimens at Brookside, Nova Scotia, on July 25, 1931. A. H. Smith made a number of collections at Warrenburg and Catlin Lake, New York, during August and September 1934 and from Oakland County, Michigan, in August and September, 1937 and October 1938.

Most of the collections were immature. In the original description of the species Berkeley states that he had not seen "ripe asci." Massee (6) described the asci and spores. The latter are given as filiform, slightly curved when free, multiseptate, 125–135 $\times$ 1 μ, the component cells 3.5 μ long. He cites only the type specimen, Ravenel *1325*. Petch (7), however, states that he examined the type specimen and it was "quite immature." The Cornell specimen was also found to be immature. Mains (5) has also noted that most of the collections from Tennessee, New York and Michigan were immature. The Hicks' specimen was the nearest to full maturity, the asci being well developed and the ascospores

[1] Paper from the Department of Botany and the Herbarium of the University of Michigan.

differentiated. It had not reached full maturity since only a few free spores were found in a mount and there is no evidence of spore discharge from the ostioles of the perithecia.

In 1938, an attempt was made to obtain thoroughly mature clavae when A. H. Smith discovered on July 10 a number of immature clavae on a rotten log near Milford, Michigan. These were inspected from time to time during the summer for exudation of spores. This did not occur and on October 24 they were collected. The clavae were in good condition. The perithecia contained asci but the spores were not fully developed. The persistence of clavae for more than three months without reaching full maturity was puzzling.

On May 29, 1939, the log at Milford was again visited and a single clava was found showing abundant exudation of spores from the ostioles of the perithecia (FIG. 1, *A*, and *B*). Of the various collections, those obtained in April and May were the most mature while those later in the season, July to October well all much less mature. This suggested the possibility that the clavae might overwinter and mature in the spring. Consequently in September 1939 the locality at Milford was again visited and eight clavae were found. Five of these had developed perithecia as shown by the presence of ostioles. These were marked by driving nails in the log beside each. In late April of 1940, the log was again visited and four clavae were found to have survived the winter, two with perithecia and two sterile. The fertile clavae were found to have well developed asci and differentiated ascospores which issued from some of the asci when mounted on a slide under a cover glass. They were not completely mature since spores were not exuding from the ostioles of the perithecia. The clavae of this species therefore can overwinter and mature in the spring. These observations strongly suggest that they start their development about July, the perithecia developing during the summer and the asci in late summer and autumn. They then overwinter and the ascospores reach maturity by the middle or the last of May.

It is now possible to give a more detailed description of the species as follows:

Clavae, single or occasionally two, ochraceous-tawny to dark cinnamon-brown, 1.5–4.5 cm. long, the fertile portion a cylindrical

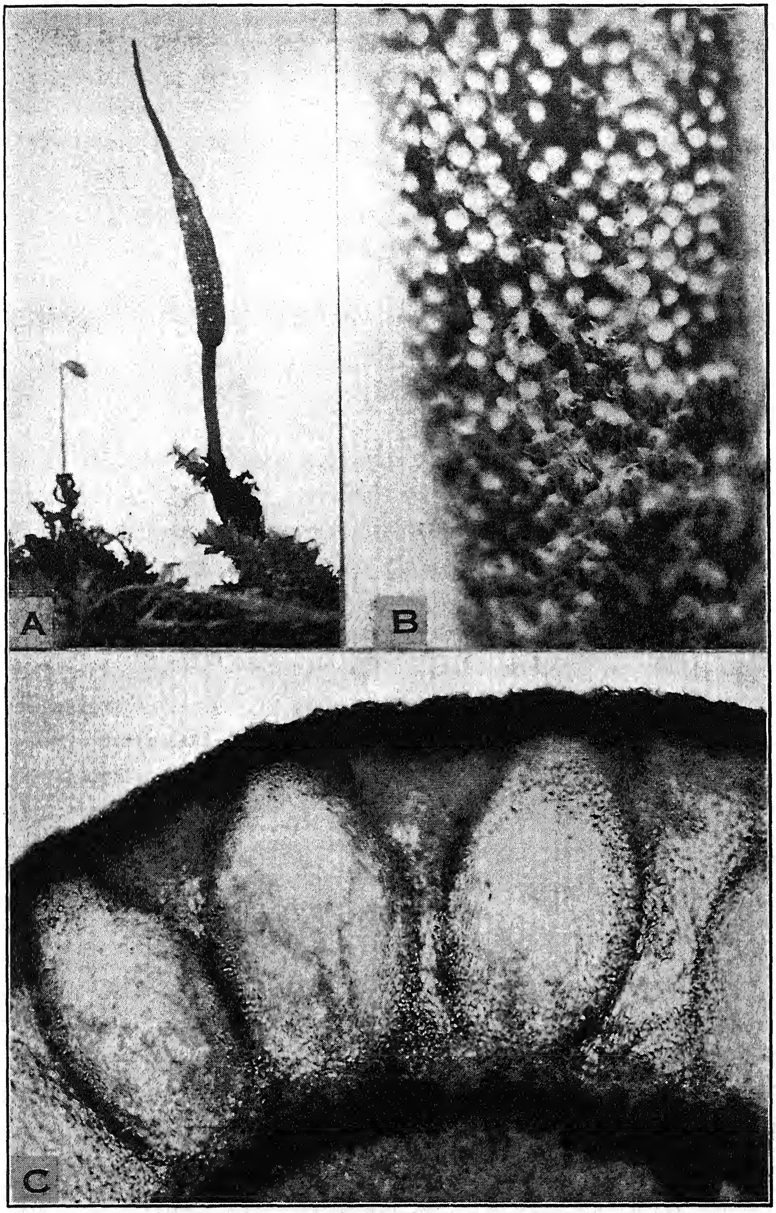

FIG. 1. *Cordyceps stylophora.*

swelling in the middle third of the clava, about 2 mm. thick, narrowed below into a sterile stipe about 0.8 mm. thick, attenuated above into a long acuminate sterile apex, the fertile portion smooth when fresh, longitudinally furowed when dry, punctate with the dark ostioles of the perithecia, the stipes surrounded at their bases by a brown mycelium; perithecia entirely embedded in the stroma, narrowly flask-shaped or ovoid, $240–420 \times 144–240\ \mu$; asci clavate-cylindric, somewhat attenuated below, slightly narrowed above, $170–220 \times 8–10\ \mu$; ascospores fusoid-cylindric, slightly narrowing at the ends, $102–164 \times 2–3\ \mu$, overlapping in the ascus, multiseptate, the cells $12–20\ \mu$ long, not regularly breaking into segments.

From coleopterous larvae in rotting logs, South Carolina, Tennessee, Michigan, New York and Nova Scotia.

Sections through the fertile portion of a clava (FIG. 1, *C*) show a somewhat similar differentiation as that described for *Cordyceps agariciformia* (*C. capitata*) by Jenkins. The differentiation is more pronounced and can be easily demonstrated from unstained, free-hand sections. There is a central cylinder composed of nearly colorless, longitudinal, parallel hyphae. Surrounding this is a thin intermediate layer of brownish, compactly interwoven hyphae. Beyond this is the perithecial layer. The perithecia are seated on and appear to arise from the intermediate layer. In the perithecial layer the perithecia are surrounded by hyphae which are nearly colorless and very loosely interwoven next to the intermediate layer becoming progressively more interwoven and colored outward, finally forming a rind of very compactly interwoven dark colored hyphae through which the ostioles of the perithecia open.

CORDYCEPS RAVENELII Berk. & Curt.

This is also a rare species. It was described by Berkeley (1) in 1857 from a collection made by Ravenel in South Carolina. Ravenel issued it in his Fungi Car. IV: 28. It has been reported from South Carolina, North Carolina, Tennessee, Kentucky, Iowa, Pennsylvania and New Hampshire. In 1940 it was discovered in a number of localities in Michigan by A. H. Smith and the writer on grubs of the June beetle. The first collection was obtained on June 4, and the clavae proved to be immature. However, they were planted in the writer's garden where they continued to develop. It was noted that the developing perithecia appeared to

break through a cortical layer. The perithecia of this species have been described as free, superficial or partially immersed. Sections through the fertile portion of a clava (FIG. 2, *A–C*) show that a considerable portion of it is a central cylinder consisting of light colored, narrow, longitudinal hyphae. Surrounding this is an intermediate layer, 30–36 μ thick, of densely interwoven hyphae. Arising from this and growing outward at right angles are numerous dark, brown parallel hyphae which form a very dense layer about 60 μ thick. The perithecia arise at intervals from the intermediate layer and apparently as they develop push through the outer layer. Where the perithecia are closely associated, the outer layer is torn loose from the intermediate and sloughs off (FIG. 2, *B*). Since the perithecia finally reach a length up to 480 μ, they appear to be superficial even where the outer layer remains (FIG. 2, *C*).

The following description is drawn from fresh specimens of the Michigan collections:

Clavae 5–9.5 cm. long, dark chocolate-brown, club-shaped, the fertile portion occupying the upper portion of the clava, 2.5–4 cm. long, 4–7 mm. thick, the apices obtuse to acute, sometimes free from perithecia, the stipes 2–3 mm. thick; perithecia at first nearly hemispherical, finally cylindric, rounded above or somewhat narrowed, 348–480 $\times$ 240–360 μ, blackish brown, at first embedded, finally becoming almost or entirely free; asci somewhat clavate, 240–312 $\times$ 8–10 μ; ascospores slightly narrowing at the ends, 192–255 $\times$ 2–3 μ, hyaline, multiseptate, the cells 20–30 μ long, only slightly segmenting.

From larvae of "June beetle," in woods, Milford, Michigan, E. B. Mains and A. H. Smith, June 4, 1940 (*5062*), June 5, 1941 (*5325*); Dexter, Michigan, June 14, 1940, A. H. Smith (*15100*); Waterloo, Michigan, June 26, 1940, A. H. Smith (*15131*); Pinckney, Michigan, June 17, 1940, E. B. Mains (*5090*); Ann Arbor, Michigan, July 3, 1940, A. H. Smith (*15174*).

Species of *Cordyceps* are commonly grouped according to whether their perithecia are embedded or superficial. Some species, as for example *Cordyceps militaris,* have been placed in both groupings. However, in *C. militaris,* the perithecia are embedded in a peripheral layer of loose hyphae without an outer compact rind.

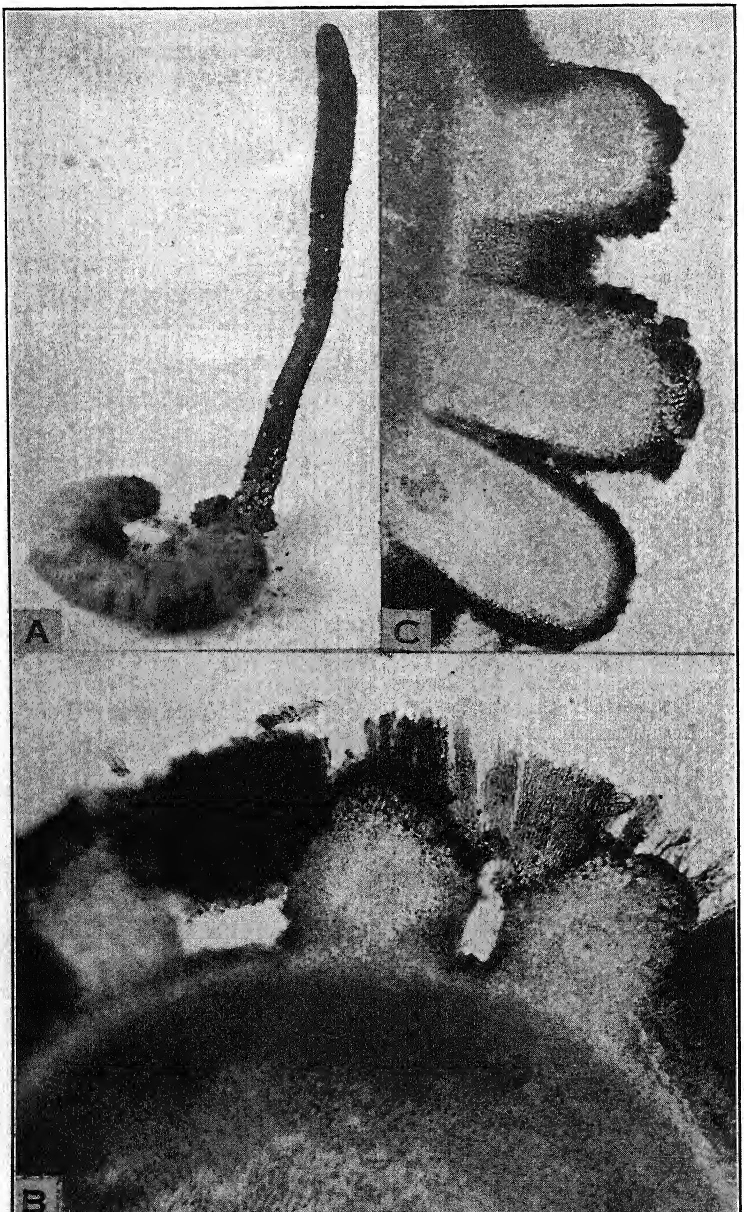

FIG. 2. *Cordyceps Ravenelii.*

Upon drying or in age, the tissue between the perithecia shrinks leaving most of each perithecium exposed and projecting. The dense outer rind of *C. stylophora* prevents this. *Cordyceps michiganensis, C. paludosa* and *C. superficialis* unquestionably have superficial free perithecia in all the collections examined. These species are very rarely collected and the available material is rather limited. From such observations as it has been possible to make it seems probable that the development of these species is similar to that of *Cordyceps Ravenelii;* the peripheral layers being very thin and the perithecia emerging very early in their development.

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EXPLANATION OF FIGURES

FIG. 1. *Cordyceps stylophora. A,* clava showing swollen fertile portion and acuminate sterile apex (1.5 ×); *B,* portion of clava, showing exudation of spores (60 ×); *C,* portion of cross section of immature clava showing central cylinder covered by intermediate layer and cortical layer containing perithecia (150 ×).

FIG. 2. *Cordyceps Ravenelii. A,* clava arising from June beetle larva (natural size); *B,* cross section of fertile portion of clava showing portion of central cylinder covered by intermediate layer from which perithecia and cortical layer arises; developing perithecia have torn portions of the cortical layer loose (105 ×); *C,* portion of cross section of clava showing half developed perithecia projecting above the cortical layer (105 ×).

OBSERVATIONS ON A NEW SPECIES OF CLADOCHYTRIUM

Arthur B. Hillegas

(with 40 figures)

During the course of an investigation of the chytrid flora of Van Cortlandt Lake in New York City, an interesting species of *Cladochytrium* was isolated from collections of water and decaying vegetation. Although at first the fungus appeared to be similar to *Cladochytrium tenue* as described by Nowakowski (**1877**) further investigation brought out significant differences which indicated that an intensive study ought to be made. Chiefly because of its exceptionally coarse and extensive rhizomycelium and the presence of numerous, non-septate, intercalary, spindle-shaped enlargements, it became apparent that it is not identical to any of the known *Cladochytrium* species or any other closely related Cladochytriaceae, and the creation of a new species seems warranted. Since the fungus is characterized by an unusually coarse rhizomycelium, the following name is proposed:

Cladochytrium crassum sp. nov.

Fungus saprophyticus; rhizomycelio copioso atque extenso, maxime crasso cum permultis tumoribus intercalaribus, non septatis, fusiformibus vel globosis, 3.85×15–$18 \times 30\,\mu$, partibus tenuissimis $1.5\,\mu$ diametro, trabeculis apparentibus. Rhizoidibus 0.5–1.1 μ diametro in rhizomycelio variatim locatis. Zoosporangiis terminalibus aut intercalaribus, raro proliferatis, sine apophysate, variatim formatis sed plerumque sphaericis ad aliqua ex re pyriformia, 11×20–$30 \times 43\,\mu$. Tubula exeunte nonnumquam usque ad $27 \times 74\,\mu$, papilla aut poro, plerumque una, deliquescente. Zoosporis intra zoosporangium disiunctis, immotili cumulo emergentibus, limo involutis, orifice tubulae exeuntis quiete aliquamdiu manentibus, mox acriter moventibus atque enatantibus. Zoospora hyalina, sphaerica ad minime pyriformem, interdum amoeboidea, 4.9–6 μ diametro cum hyalino globulo maxime refractivo 2–2.75 μ diametro, flagello posteriore 25–35 μ, rapide et emicatim enatante. Spora perdurante sphaerica (9.35–23 μ diametro) vel fusiformi ($10 \times 26\,\mu$–$14.8 \times 23.1\,\mu$), pariete 1.5 μ crasso, subfusco colorato, germinatione incomperta.

Rhizomycelium well developed, extensive, coarse, with numerous intercalary, non-septate, fusiform to globose swellings 3.85×15–

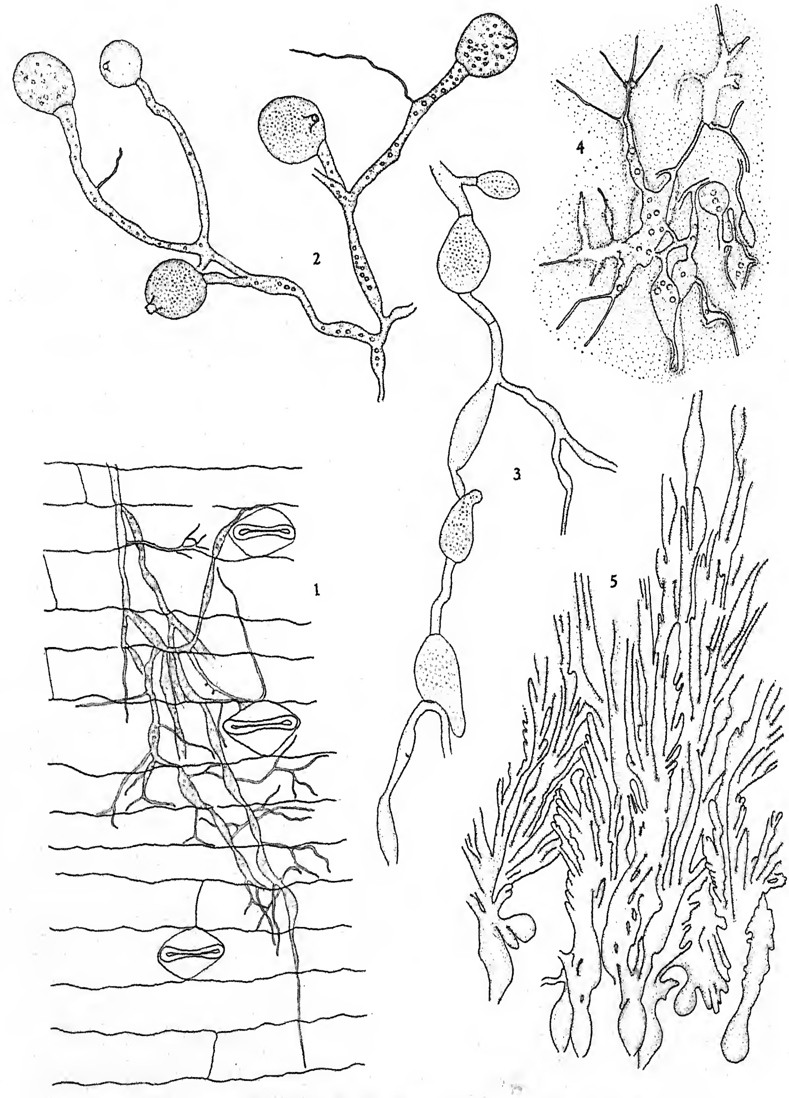
$18 \times 25\ \mu$, the tenuous portions as little as $1.5\ \mu$ in diameter, with trabeculae. Rhizoids $0.5\ \mu$ to $1.1\ \mu$ in diameter originating at various places along the rhizomycelium. Zoösporangia terminal or intercalary, seldom proliferating, non-apophysate, variously shaped, commonly spherical to slightly pyriform, $11 \times 20\text{–}30 \times 43\ \mu$. Exit tube occasionally to $27 \times 74\ \mu$, papilla or pore, usually single, deliquescent. Zoöspores delimited within zoösporangium and emerging in a non-motile mass enveloped in slime, which remains at the mouth of the exit tube a few minutes before the zoöspores become active and swim away. Zoöspore hyaline, spherical to slightly pyriform, occasionally amoeboid, 4.9–6 μ in diameter with a clear highly refractive globule 2–2.75 μ in diameter, posterior flagellum 25–35 μ, swimming rapid and darting. Resting spore spherical (9.35–23 μ diameter) to fusiform ($10 \times 26\ \mu$–$14.8 \times 23.1\ \mu$), wall 1.5 μ thick, light brown in color, germination unknown. Saprophytic on decaying vegetation from Van Cortlandt Lake, New York City.

APPEARANCE OF THE FUNGUS IN CULTURE

The fungus was first observed in dechlorophyllized corn leaves which had been used to bait the original collections of pond water. From this mixed culture unifungal cultures were established on bleached corn leaves and non-waterproof cellophane, and in pure culture upon 0.5 and 3 per cent plain agar. The methods employed in isolating these cultures are essentially those which have been employed by Couch (1939) and Cox (1939).

For a life history study of *Cladochytrium crassum* bleached corn leaves proved to be the best substratum, because on it the thallus develops normally and abundantly. The rhizomycelium characterized by its conspicuous, irregular, globose, or spindle-shaped swellings may grow intramatrically (FIG. 1) and partially or entirely extramatrically, frequently extending into the surrounding water and giving a distinctly fuzzy appearance to the margin of the corn leaf. Usually the rhizomyceloid development of the thallus is well established before the terminal (FIG. 2) or intercalary (FIG. 3) zoösporangia are formed. Although zoösporangia are distributed throughout the whole substratum they are particularly abundant about the vascular system, especially in old cultures.

Another substratum used successfully for maintaining cultures of the fungus was non-waterproof cellophane, a substratum introduced into chytrid work by Haskins (1939). Although this is



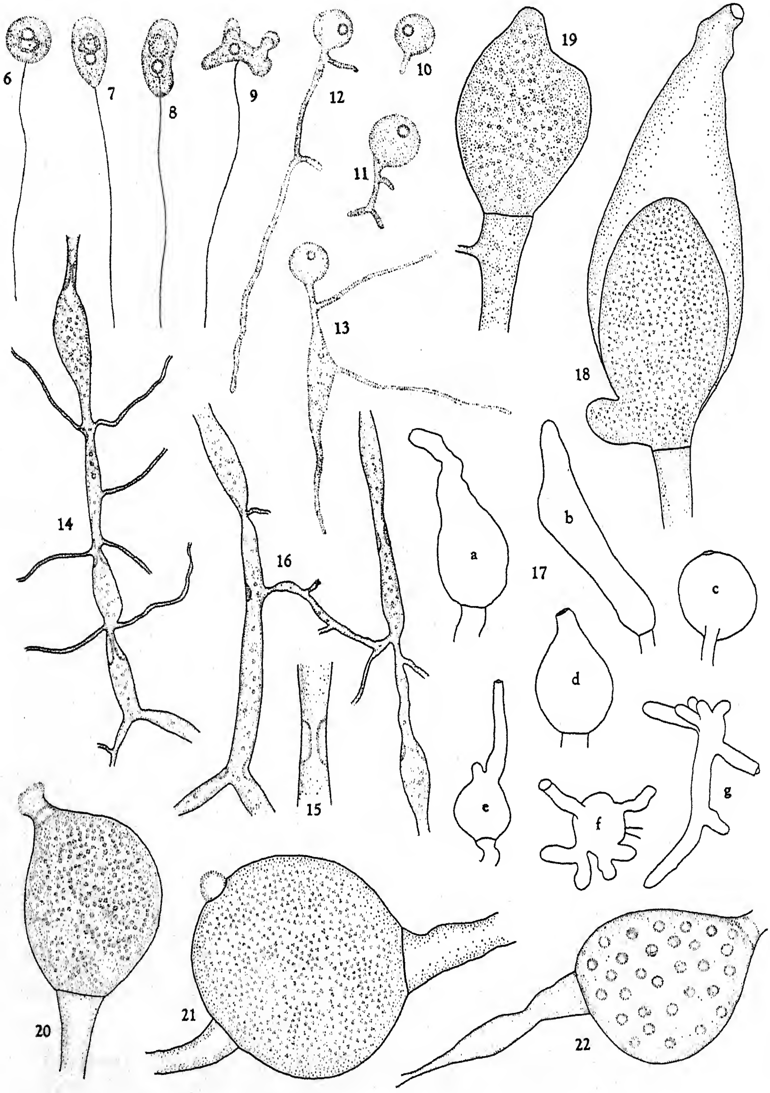
FIGS. 1–5. 1, thallus growing in dechlorophyllized corn leaf, × 296; 2, rhizomycelium with terminal zoösporangia, × 296; 3, intercalary zoösporangia, × 296; 4, young thallus growing upon cellophane, × 1187; 5, old thallus scraped from cellophane showing anastomoses between branches.

excellent for culturing purposes it is not desirable for observation of the fungus because of the similar optical properties of the fungus and the cellophane, and the reduced and distorted thallus that is produced. Usually about ten days after inoculation white patches or mats of the fungus on the cellophane are to be observed with the unaided eye. Instead, however, of expanding widely on the cellophane as it does on the bleached corn leaves, the fungus displays an abundant but compacted and distorted growth on the surface of the cellophane radiating centrifugally from the point of infection (FIG. 4). Immediately upon germination of the zoöspore, branching and enlargement and anastomosis of the germ tube occurs (FIG. 4). The delicate tips of the rhizomycelium lie plainly on the surface of the cellophane but the proximal portion is less clearly defined and appears to be partially enveloped, possibly because of the swelling of the cellophane induced by enzymic action. An old empty thallus scraped from the cellophane, flat and rigid, shows what an intricate labyrinthine pattern is formed by the reduced growth and the anastomoses between branches of the thallus (FIG. 5). The zoösporangia produced on cellophane, unlike the vegetative growth, appear to be quite normal except in places where they have developed so abundantly that they are packed and squeezed together into irregular shapes.

Cladochytrium crassum has been grown on 0.5 and 3 per cent plain agar, and on these media the thallus development is quite normal. The rate of growth is nevertheless slow requiring two weeks to acquire a colony 6 mm. in diameter on 3 per cent agar. In such cultures growth takes place both deep within and on the surface of the medium. Zoösporangia are developed but zoöspores have not been observed to be liberated from the zoösporangia at the concentrations of agar thus far employed. Further experiments will determine the relative suitability of various agar media.

DEVELOPMENT OF THE FUNGUS

The zoöspore of *C. crassum* is typical of the genus *Cladochytrium*. The single highly refractive globule is hyaline in contrast to the golden-red refringent globule of *Cladochytrium replicatum* (Karling, **1931**), *Cladochytrium Nowakowski* (Sparrow, **1931**), and *Cladochytrium polystomum* (Zopf, **1884**). The zoö-



FIGS. 6–22. 6, motile zoöspore, × 1175; 7–9, amoeboid zoöspores, × 1175; 10, early stage in germination of zoöspore, × 1175; 11, 12, branching of the germination tube, × 1175; 13, initial swelling on the germ tube, × 1175; 14, intercalary swellings of mycelium and trabeculae, × 572; 15, enlarged view of trabecula, × 1175; 16, anastomosis between two branches of rhizomycelium, × 572; 17 *a–g*, various sporangial shapes, × 382; 18, proliferation of a zoösporangium, × 1175; 19, early stage in the development of a zoösporangium with exit tube forming, × 1175; 20, late stage in the dispersal

spores are spherical to slightly pyriform 4.9 to 6 μ in diameter, hyaline, occasionally with small vacuoles, with a posteriorly attached flagellum 35 μ long which compares favorably with those reported for *Cladochytrium tenue* (Nowakowski, 1877). A conspicuous spherical highly refractive globule 2–3 μ in diameter is contained in each spore usually in a fairly central position (FIG. 6, 7). Adjacent to the refractive globule is a clear spherical body bordered by a denser material which appears to be the nucleus surrounded by a nuclear cap.

The zoöspore swims forward in the usual jerky manner of a chytrid, darting from one obstruction to another. This active swimming stage of the zoöspore is frequently interrupted by an amoeboid condition of varying duration in which the active zoöspore comes to rest, becomes amoeboid, and then weakly creeps about trailing its inactive flagellum (FIG. 8, 9). During the amoeboid phase the nucleus and nuclear cap material remain closely associated with the highly refractive globule in the dense cytoplasm. The optically homogeneous pseudopodia which extend out in the direction of movement are definitely less dense than the central portion of the zoöspore.

After a swimming period of a few minutes to several hours the zoöspore comes to rest on the substratum, rounds up preliminary to germination, and either drops or retracts its flagellum. The protoplasm now assumes a greyish hue and all the structures in the zoöspore that have been so clearly defined in the hyaline protoplasm now become indistinguishable except the highly refractive globule. Within a few minutes the germ tube emerges from the surface of the zoöspore as a small papillate structure which elongates into a fine hyaline filament 2 μ in diameter (FIG. 10) and branches either near the zoöspore (FIG. 11) or at some distance away (FIG. 12). As the germ tube elongates, gradual vacuolation of the zoöspore takes place until it is devoid of any protoplasm except the highly refractive globule and this too soon disintegrates. Very soon afterwards intercalary enlargements make their appear-

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of highly refractive substance in the protoplast; deliquescence of exit papilla, $\times$ 1175; 21, intercalary sporangium in granular stage with exit pore, $\times$ 1175; 22, mature zoösporangium with refractive substance localized in each zoöspore initial, $\times$ 1175.

ance in the germ tube (FIG. 13), the initial stages of the spindle-shaped swellings which are so strikingly characteristic of the thallus. The germination therefore is not different in important respects from that reported for other Cladochytriaceous species.

The germ tube represents the rudimentary rhizomycelium which by its growth, branching and rebranching forms a very extensive and complicated thallus. The most striking feature of the thallus is its spindle-shaped, or less frequently, irregular (FIG. 1) or globose swellings. They may attain a diameter of 18.7 μ while the more tenuous portions are less than 3 μ in diameter and the extremely delicate tips are never more than 1 μ. A hyaline protoplasm in which are dispersed highly refractive globules fills the young thallus while the older ones which have been differentiated into vegetative and reproductive structures are devoid of protoplasm in the filamentous portion. The protoplasm appears to be drained into the incipient zoösporangia although occasionally extremely vacuolated protoplasm may remain in the filament where it soon disintegrates, possibly indicating that not all of the protoplasm is utilized in the formation of the zoösporangia.

The spindle-shaped swellings of *Cladochytrium crassum* are not septate as they have been shown by Nowakowski (**1877**) for *Cladochytrium tenue*. This is one of the fundamental differences between these two species. Furthermore the relationship between the spindle organ and the more tenuous portion of the rhizomycelium is another point of contrast. The figures of Nowakowski (**1877**) indicate that the spindle organs of *C. tenue* are of fairly uniform size and shape and that they taper rapidly to the tenuous portions of the rhizomycelium which likewise maintain uniformity in diameter. On the other hand, *C. crassum* exhibits no uniformity either in size and shape of its spindle-shaped swellings or in the diameter of its tenuous portions. Frequently one swelling may follow another in catenulate fashion without the interval between the swellings becoming sufficiently reduced to be called tenuous, thus presenting a thick appearing mycelium (FIG. 2). This same comparison might be made with *Cladochytrium replicatum* (Karling, **1931**, **1935**, **1937b**) and *Cladochytrium Nowakowski* (Sparrow, **1931**). The type of swelling found in this new species is in most respects similar to those of *Amoebochytrium*

rhizidioides (Zopf, 1884), *Cladochytrium cornutum* (de Wildeman, 1896), *Nowakowskiella ramosum* (Butler, 1907), *Nowakowskiella elegans* (Matthews, 1928; Sparrow, 1933), *Nowakowskiella endogena* (Domjan, 1935), *Physocladia obscura* (Sparrow, 1933) and *Septochytrium variabile* (Berdan, 1939).

Another distinguishing characteristic of the rhizomycelium of this species is the trabeculae or thickenings within the filamentous portion of the thallus. These bands may be so thick as to leave only a small pore through which the protoplasm can flow or they may only partially surround the mycelium and scarcely retard the flow of the protoplasm (FIG. 14, 15, 16). These trabeculae are usually located at a constriction in the mycelium or just at the expanding portion of the intercalary swelling. Partial thickenings are located at various places along the mycelium but most often at the junction of the branches or rhizoids or at other partial obstructions in the filament (FIG. 16). Until the present time thickenings of this type among chytrids have been reported only in *Septochytrium variabile* (Berdan, 1939). Occasionally anastomosis between the branches of the rhizomycelium may occur (FIG. 16), but this does not appear to serve any particular function.

The zoösporangia are either terminal or intercalary in the rhizomycelium as has already been shown (FIG. 2, 3, 21) and exhibit great diversity in size and shape and in the length of exit tube. They are typically globose or pyriform measuring $11 \times 20\ \mu$–$30 \times 43\ \mu$ (generally $34\ \mu$ in diameter) while others may be irregular or spindle-shaped. A few of the infinite number of shapes which the zoösporangia may assume are shown in figures 17*a–g*. The zoöspores may be discharged through a long and slender exit tube up to $46\ \mu$ in length and 3.5–$5\ \mu$ in width, or by means of a very short exit papilla, or by simply a pore. More than one exit tube seldom occurs (FIG. 17*g*) and although as many as three of them have been observed only one has ever been functional.

The zoösporangia originate as terminal or intercalary swellings which have become delimited from the vegetative portion of the thallus by cross-walls (FIG. 19). Whether or not the protoplasm of the rhizomycelium is entirely used up in the formation of the zoösporangia was not determined. It is observed, however, that the protoplasm is absent from the older portions of the mycelium

and often in those parts adjacent to the sporangia. This may be the result of drainage of the protoplasm into the sporangia or possibly degeneration of it. Proliferation of the sporangium occurs infrequently (FIG. 18).

The subsequent enlargement and maturation of the zoösporangium is accompanied by certain changes in the protoplast. In the initial enlargement are numerous small highly refractive globules scattered throughout the hyaline protoplasm (FIG. 19, 20). These increase in number as the incipient sporangium enlarges, but just before the cleavage of the protoplast into zoöspores, these globules become uniformly dispersed throughout the hyaline protoplasm in the form of minute granules (FIG. 21), imparting a finely granular appearance to it. This dispersion allows equal amounts of the highly refractive substance to be included in each of the zoöspore initials at cleavage. The optical homogeneity of the protoplasm makes it impossible to follow the cleavage stages in the protoplast. Zoöspore delimitation, however, follows the highly dispersed phase of the refractive material because gradually the refringent substance, by fusion of the minute particles, becomes localized to form the highly refractive globule of the zoöspore (FIG. 22). The changes that occur in the protoplast have for the most part been described for many of the rhizidiaceous and cladochytriaceous fungi by Karling, Couch, Berdan, Hillegas and others.

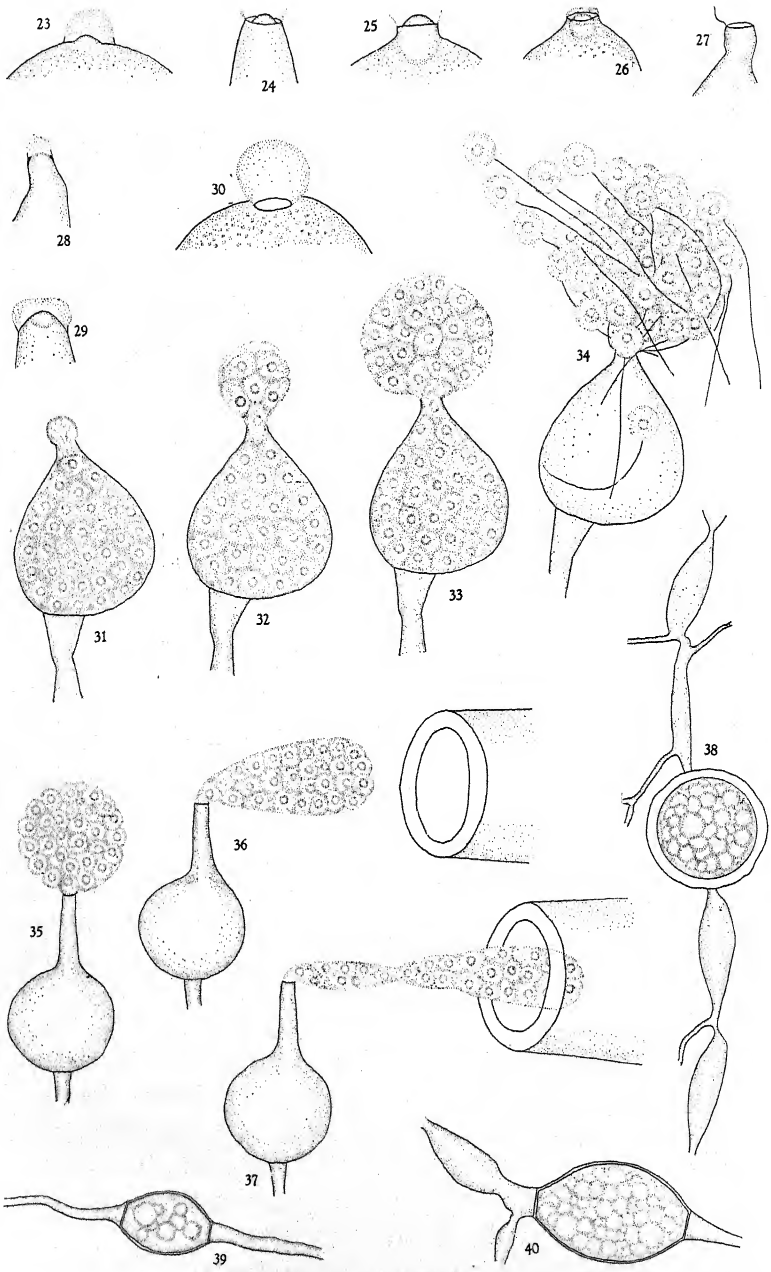
The discharge of the zoöspores of *Cladochytrium crassum* may occur through an exit tube, a papilla (FIG. 2), or a pore (FIG. 21). If a tube is formed it begins as a bulge on the surface of the sporangium (FIG. 19) and elongates rapidly attaining in one instance a length of 14 μ in one hour. Except under unfavorable circumstances long tubes are not formed. This development occurs before the highly refractive material becomes dispersed throughout the protoplast. The preliminary steps involved in the preparation of the opening through which the zoöspores are to be discharged are fairly complicated. At the tip of the exit tube or papilla, or in the case of the simple pore, on the surface of the sporangium itself, a bulge becomes evident which appears to be caused by the separation of inner and outer layers of the sporangial wall. In the space thus formed between the two layers a clear substance forms which might conceivably be the products of the

deliquescence of the outer layer. When this outer layer eventually disappears leaving only traces in the form of a ring (FIG. 24, 25, 26, 29) the hyaline substance also soon disappears leaving the inner membrane of the wall exposed. This membrane similarly has a bulge (FIG. 23, 24, 25, 26) directly inside of which is evident a second spherical-shaped mass of viscid substance (FIG. 25, 26). Upon the rupturing of this inner membrane, this viscid substance serves as a temporary plug and is pushed out ahead of the zoöspores (FIG. 31).

Zopf (**1884**) figured a plug-like structure in the exit tube of *Amoebochytrium rhizidioides* and Ward (**1939**) in *Rhizophlyctis rosea* has shown a cushion-like plug in the mouth of the exit tube which may correspond to the substance found between the outer and inner membranes in *Cladochytrium crassum*. For *Cladochytrium hyalinum* Berdan (**1941**) showed a cushion of hyaline substance in the mouth of the exit tube but outside the inner membrane. This substance she believes to serve as a plug preceding the discharge of the zoöspores and to later surround the released zoöspores. In *C. crassum,* on the other hand, the substance which corresponds to the cushion in *C. hyalinum* entirely disappears before the zoöspores emerge and it is the viscid substance beneath the inner membrane which precedes the escaping zoöspores and partially or possibly completely surrounds them upon their discharge.

In two instances empty blister-like protuberances were seen (FIG. 30) resembling a vesicle extruding from the pore, but in neither case did the protoplasmic contents flow into this such as has been described by Sparrow (**1932**) in the discharge of the spores of *Physocladia obscura*.

Following the breaking of the membrane at the mouth of the exit tube, the clear substance which up to this time has remained just below the bulging membrane (FIG. 25, 26) appears to function as a plug which restrains the zoöspores from escaping (FIG. 22). As the zoöspores emerge pushing the viscid material before them (FIG. 31), this clear substance forms a cap over the top of them (FIG. 32) which gradually thins out over the zoöspore mass as the mass enlarges, but because of its hyaline nature it soon becomes indiscernible. Ultimately the entire mass of zoöspores flows out



Figs. 23–40.

of the sporangium and remains at the mouth of the exit tube as a spherical mass of amoeboid bodies so closely pressed together that they assume polygonal shapes (FIG. 33). The zoöspores now round up, then gradually become active and with their flagella moving weakly they swarm about within a limited space before they become dispersed and swim away (FIG. 34).

As the figures and description indicate, there is some evidence in support of the view that there is a membrane or vesicle surrounding the zoöspores. Immediately after discharge the zoöspores appear to have a cap of clear fluid which at some times appears to act like a membrane. For example the restrained swarming of the zoöspores at the mouth of the exit tube prior to their liberation into the surrounding medium might be considered a proof of the existence of a membrane. This limitation of swarming cannot have been caused by a bacterial slime because it has been observed in cultures which have been thoroughly washed. Furthermore, when these zoöspores after a minute begin to swim away they do not, as in *Endochytrium operculatum* (Karling, **1937a**), break forth in all directions, but emerge usually at one, occasionally at two, spots from the zoöspore mass, a behavior that could be the result of the presence of some limiting membrane which ruptured at one or two places thus permitting the liberation of the zoöspores. The zoöspores are well bound together by some means.

FIGS. 23–40. 23, early stage in the deliquescence of exit pore, × 1134; 24, exit tube with remnants of outer wall and bulge showing on inner membrane, × 1134; 25, exit papilla on maturing zoösporangium; fragments of outer wall bulge on inner membrane with globule of viscid substance below, × 1134; 26, oblique view of exit papilla; fringe formed by old outer wall, × 1134; 27, exit tube with inner membrane ripped off; 28, thickened ring formed at contact of outer wall and inner membrane of exit tube, × 1134; 29, exit tube with outer wall partially ripped thus showing inner membrane, × 1134; 30, vesicle at mouth of exit pore, × 1134; 31, zoöspore discharge; viscid fluid flowing from exit papilla, × 1134; 32, viscid substance spreading out over emerging zoöspores, × 1134; 33, later stage of zoöspore discharge, viscid substance not visible, × 1134; 34, zoöspores fully discharged and swimming away, × 1134; 35, zoöspore mass at mouth of exit tube; 36, zoöspore mass being stretched towards micropipette; 37, mass of zoöspores showing extreme elasticity; 38, intercalary thick-walled resting spore, × 1134; 39, 40, thin-walled intercalary resting spores, × 1134.

In spite of this evidence, however, I do not believe that there is any membrane around the zoöspores of *C. crassum* as in *Pythium* or *Physocladia obscura*. Even after repeated and long observation I have been unable to discern any traces of such a vesicle. Sparrow (**1932**) reported *Physocladia obscura* as possessing a vesicle within which the zoöspores swarmed before they were released. The zoöspores of *C. crassum* swarm no longer than one minute thus making the existence of such a vesicle highly improbable in this form. It is my belief, therefore, that the zoöspores of *C. crassum* are embedded in a matrix or surrounded by a slime which momentarily retards the free swimming of the escaped zoöspores. The extreme viscidity of the matrix or slime was demonstrated when making a unifungal culture. A pipette placed near the mass of discharging zoöspores (FIG. 35) could stretch the mass of zoöspores away from the mouth of the exit tube into a long strand (FIG. 36, 37) without separating the mass, and when suction was released the mass snapped back elastically into its original shape and position.

RESTING SPORE

Resting spores form rather abundantly in old cultures to which fresh water has not been added for at least two weeks. They exhibit characteristics similar in most respects to those reported for other members of the genus *Cladochytrium*. They are intercalary, spherical (FIG. 38) or fusiform (FIG. 39, 40) with a smooth hyaline wall 1.5–2 μ in thickness. They appear to form within the intercalary swellings and are cut off from the rhizomycelium by septa. The contents of the resting spores consist of several large highly refractive globules that fill the interior of the spore. Resting spores have been reported for six of the recognized species of *Cladochytrium: C. graminis* (Büsgen, **1887**) which have thick light brown resting spore walls; *C. replicatum* (Karling, **1935**) (*C. Nowakowski* Sparrow, **1931**) with smooth and rough hyaline walls; *C. caespitis* (Griffon and Maublanc, **1910**) whose resting spores have smooth, slightly yellowish walls 2–5 μ thick; *C. irregulare* (de Wildeman, **1895**) which has terminal or intercalary resting spores; *C. viticolum* (Prunet, **1894**) with resting

spores having thick, smooth walls; and *C. hyalinum* (Berdan, 1941) which has smooth, thin walled resting spores.

It is evident from this that the general morphological character of the resting spore of *C. crassum* is for the most part similar to that of other species of *Cladochytrium*. The germination of the resting spore has not been observed.

DISCUSSION

The fundamental characteristics on the basis of which the new species has been created make the fungus easily distinguishable from its closest relative *Cladochytrium tenue*. The new species displays a coarse rhizomycelium with intercalary non-septate swellings and prominent trabeculae. Resting spores have also been observed. In *Cladochytrium tenue,* however, the rhizomycelium is tenuous except for the spindle organs which are bi-cellular instead of non-septate, and no trabeculae nor resting spores have been reported thus far.

SUMMARY

1. A new species of *Cladochytrium* has been isolated in unifungal culture on dechlorophyllized corn leaves and non-waterproof cellophane, and in pure culture on 0.5 and 3 per cent plain agar.

2. The development and structure of the fungus has been described.

3. The specific name *crassum* has been proposed for this new species because of its coarse rhizomycelium.

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DICTYOSTELIUM MINUTUM, A SECOND NEW SPECIES OF SLIME MOLD FROM DECAYING FOREST LEAVES [1]

KENNETH B. RAPER [2]

(WITH 4 FIGURES)

INTRODUCTION

Species of the Dictyosteliaceae, a group of pseudoplasmodium-forming slime molds, are generally distinguished by one or more of the following characters: (1) the color of the spore masses, or *sori,* (2) the form of the fruiting structures, or *sorocarps,* and (3) the maximum dimensions of such sorocarps. Of these characters, the latter is the most variable and, in general, the least satisfactory. Nevertheless, sorocarp size provides a reasonable basis for species separation and description if adequate safeguards are taken to establish and maintain optimum cultural conditions. To this end it is essential to cultivate members of this group with the same bacterial associates, and, insofar as possible, to standardize critical environmental factors at favorable and reproducible levels. Such factors include (1) the nutrient composition of the substratum, (2) the moisture content of the air within the culture chambers, (3) the temperature of incubation, and (4) the pH of the host bacterial colonies (Raper, **1937, 1939, 1940b**). Upon observing these precautions, whenever a particular isolate consistently shows marked differences in sorocarp size from known species in culture, and likewise differs from the description of previously published species,

[1] The slime mold described was isolated and studied while the writer was employed in the Division of Soil Microbiology, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

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the designation of such a form as new appears warranted. Such has been the writer's experience. Upon three occasions and from widely separated localities a *Dictyostelium* has been isolated from forest litter which invariably produces smaller sorocarps than any known member of the genus. Because of the diminutive character of its sorocarps, the species is designated as follows.

TECHNICAL DESCRIPTION [3]

Dictyostelium minutum sp. nov.

In culturis artificiosis, sorocarpis perminutis, solitariis vel gregariis, plerumque 500–850 μ altis, interdum majoribus, saepe minoribus, frequenter ramosis; sorophoris ex hyalinis griseo-albis, rectis, basi 12–18 μ, apicem versus 2.5–6 μ in diam. paulatim attenuatis, supra flexuosis, parte basali excepta e strato uno cellularum compositis; soris ex hyalinis lacteo-albis, rotundato-apiculatis, plurimum 75–125 μ in diam., aliquando majoribus; sporis ellipticis, hyalinis, 5–7 μ longis, 3.0–3.5 μ latis.

Ex foliis putrescentibus in silvis deciduis isolatum, Virgnia, Massachusetts, et Maryland.

Cultivated upon hay-infusion, dung-infusion, and weak peptone agars in association with *Escherichia coli, Pseudomonas fluorescens, Serratia marcescens, Bacillus megatherium,* and *Bacillus firmus* at temperatures between 20 and 25° C., sorocarps diminutive, solitary or gregarious, commonly 500 μ–850 μ in height, occasionally larger, often smaller, frequently branched; sorophores colorless to grayish white, erect, 12 μ–18 μ in diameter at the base, tapering gradually to 2.5 μ–6 μ in diameter above, terminal region flexuous, commonly consisting of a single tier of cells except in basal portion; sori colorless to milk-white, rounded-apiculate, commonly 75 μ–125 μ in diameter, occasionally larger; spores elliptical, hyaline, 5 μ–7 μ × 3.0 μ–3.5 μ.

Isolated from leaf mould from deciduous forests. Virginia, Massachusetts, and Maryland.

ISOLATION AND CULTURE

The type culture of *Dictyostelium minutum,* No. V–3, was isolated in October 1937 from a sample of forest litter collected from a hardwood forest near Vienna, Virginia. The site of collection

[3] The writer is indebted to Edith K. Cash, Bureau of Plant Industry, for preparing the Latin diagnosis.

was near a small stream, and the flora in the immediate vicinity consisted of maples, ash, alder and deciduous ferns. These forms, together with oaks and beeches from the adjacent slopes, con-

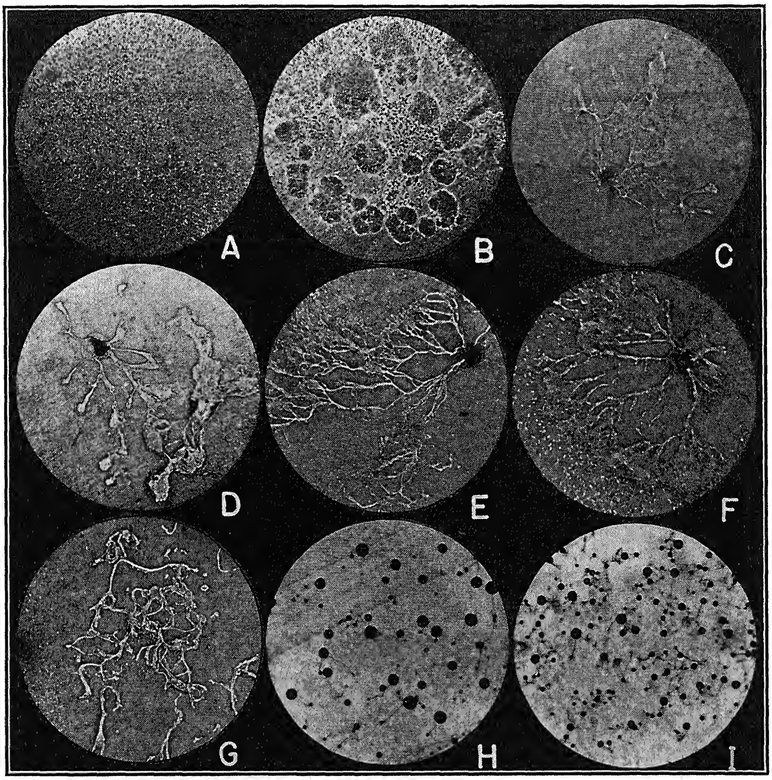

FIG. 1. *Dictyostelium minutum* growing in association with *Escherichia coli* at 22°–23° C.; figures with exception of I taken from 0.1% peptone agar plates. *A,* close of vegetative stage, myxamoebae unoriented; *B,* early fruiting stage, aggregates not showing converging streams; *C–F,* pseudoplasmodia showing conspicuous centers and converging streams of myxamoebae; *G,* pseudoplasmodium not showing definite center of aggregation; *H,* mature sorocarps on 0.1% peptone agar; and *I,* mature sorocarps on hay-infusion agar. *A–G,* × 35; *H–I,* × 10.

tributed to the leaf mould layer. The material from which the slime mold was isolated remained fairly most at all times and consisted of decomposing leaf fragments together with the topmost layer of underlying soil. From the same sample of approximately

40–50 grams, cultures of *Dictyostelium mucoroides* Brefeld (1869), *Polysphondylium violaceum* Brefeld (1884), and *P. pallidum* Olive (1901) were likewise secured.

The slime molds were isolated as follows: A portion of the sample was macerated in a clean mortar with approximately ten volumes of sterile water and the resulting suspension streaked upon dilute hay-infusion agar [4] plates. These were subsequently incubated at 22° C. ±. Beginning on the third day following inoculation, the plates were examined daily. Pseudoplasmodia characteristic of the Dictyosteliaceae appeared on the fourth day and by the following morning had developed into typical but relatively small sorocarps of *Dictyostelium mucoroides* and *Polysphondylium violaceum*. On the sixth day sorocarps of *P. pallidum* were likewise evident. The three species were isolated directly in pure-mixed culture with *Escherichia coli*. Meanwhile, in a single plate, small pseudoplasmodia appeared which subsequently developed into diminutive white-headed sorocarps. These were almost completely masked by an overgrowth of Mucors and other fungi. After removing this covering as carefully as possible, minute quantities of unaggregated myxamoebae and accompanying "host" bacteria were removed with a small loop and streaked upon fresh plates of dilute hay-infusion agar. By repeating this procedure the fungi were soon eliminated and the slime mold was eventually obtained in pure-mixed culture associated only with a single species of bacteria upon which it fed. In addition to dilute hay-infusion agar, subsequent transfers were made upon full-strength hay-infusion, dung-infusion, and weak peptone agars containing either 0.05 per cent or 0.1 per cent of this nutrient. The slime mold has been grown continuously upon these media since the date of its isolation, being frequently shifted from one to another.

In the light of previous experience (Raper, 1939, 1940b) environmental factors known to influence processes of growth and development in the Dictyosteliaceae have been controlled as accurately as deemed necessary. Culture media have regularly been adjusted to an initial pH of 6.0 and quantities of phosphate buffers ($Na_2HPO_4 \cdot 12H_2O$ and KH_2PO_4) have been added whenever

[4] Hay infusion agar as earlier described (Raper, 1937) diluted to one fourth its original nutrient strength.

necessary to prevent any appreciable deviation from this level. Cultures for examination have been grown in Petri plates consisting of close fitting valves, insuring the maintenance of a saturated or near saturated atmosphere within the culture chambers throughout the period of growth and sorocarp development. Incubation temperatures have ranged from 20°–25° C., but have generally been maintained at approximately 22°–23° C. The latter temperature appears to be optimum for the species.

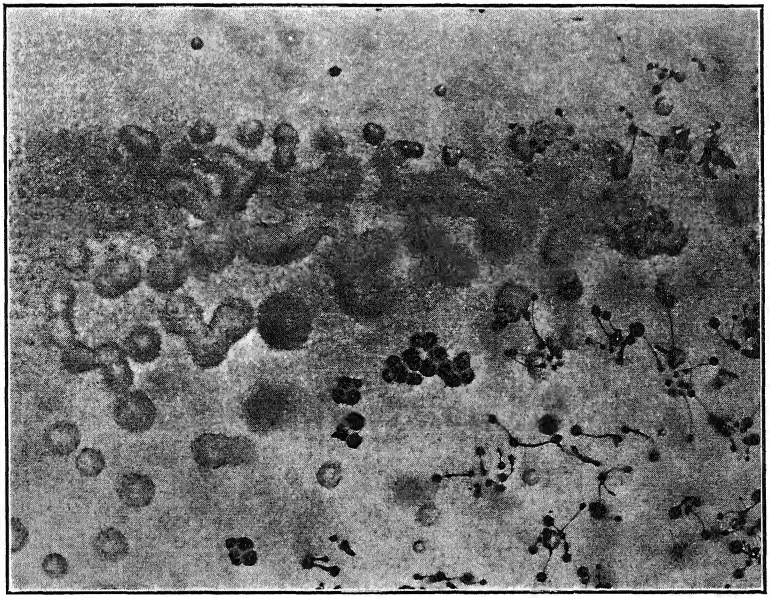

FIG. 2. Fructification of *Dictyostelium minutum* in association with *Escherichia coli* upon hay-infusion agar. Upper left, initiation of fruiting phase; left center, pseudoplasmodium formation by the blocking-out of masses of myxamoebae; right center, early stages in sorocarp formation; lower right, mature sorocarps. × 10.

The bacterium accompanying *Dictyostelium minutum* at the time of its isolation and subsequently associated with it in the writer's stock cultures has been identified as *Bacillus firmus* Bredemann and Werner.[5] In association with this host organism the diminu-

[5] Determination by Ruth E. Gordon and Nathan R. Smith, Division of Soil Microbiology, Bureau of Plant Industry, U. S. Department of Agriculture.

tive size and character of the sorocarps remained essentially constant (1) upon each of the above media and (2) throughout the period of observation which covered more than a score of culture generations. The number of sorocarps, however, was consistently much greater upon the richer culture media. The fact that the size of its fruiting structures did not increase proportionately with its increased growth strongly indicated that their diminutive nature constituted an inherent and distinguishing character of this particular slime mold. Nevertheless, there remained the possibility that the smallness of its sorocarps might in some manner be related to and result from some property of the associated bacteria. To test this possibility, and to provide a reliable basis for comparison with other species of the Dictyosteliaceae (Raper, **1937**, **1940a**; Raper & Thom, **1941**) the slime mold was placed in pure-mixed culture with the following selected bacterial species: *Escherichia coli* (Migula) Castellani and Chalmers, *Pseudomonas fluorescens* Migula, *Serratia marcescens* Bizio (*Bacillus prodigiosus* Flügge), and *Bacillus megatherium* DeBary.

The growth of the slime mold was approximately the same in association with the "stock" bacterium, *Bacillus firmus,* and each of the substitute associates upon quarter-strength hay-infusion and 0.05 per cent peptone agars. Upon richer media including full-strength hay-infusion and dung-infusion agars growth was generally more luxuriant with *E. coli* than with either of the other associates. The colonies of this species were entirely consumed as a rule, whereas the colonies of other species commonly were only partially consumed. Very unsatisfactory results were obtained with *Pseudomonas fluorescens* and *Serratia marcescens* upon unbuffered media containing 0.1 per cent or more of peptone. However, by adding adequate phosphate buffers (M/100 in KH_2PO_4 and in $Na_2HPO \cdot 12H_2O$) and subsequently adjusting the medium to pH 5.0 or 5.5 rich cultures were obtained with both associates.

Upon the weaker substrata the majority of sorocarps in every instance were produced singly. Upon more concentrated media, where the growth of the slime mold was much greater and the number of fructifications correspondingly increased, there was a pronounced tendency for the sorocarps to be clustered. In no case, however, were individual fruiting structures materially larger

than in the less luxuriant cultures. It was obvious, therefore, that the small dimensions of its sorocarps represented an inherent character of this slime mold, and was not the result either of the bacterial species with which it was associated or the substratum upon which it was cultivated.

In cultures with *Serratia marcescens* the myxamoebae of *Dictyostelium minutum,* like those of *D. mucoroides* as recently reported by Raper and Thom (**1941**), either digest or discard the red bacterial pigment, *prodigiosin,* during the feeding process. Consequently, the myxamoebae remain practically uncolored and in fruiting build sorocarps characterized by colorless stalks and colorless to milk-white sori. In this, as in a number of other respects, the species closely resembles *D. mucoroides.* There is, in fact, every reason to believe that the two slime molds represent possible extremes in a somewhat graduated series.

SPORES

The spores of *Dictyostelium minutum* are characteristically elliptical (capsule-shaped), hyaline, and in size commonly range between $5\ \mu$–$7\ \mu \times 3\ \mu$–$3.5\ \mu$. Individual spores may be larger or smaller, and in addition may be either more or less elongate than is indicated by the above figures. Subspherical spores are occasionally seen. In all of these characters the spores resemble closely those of the very common species *D. mucoroides.* In fact, it is apparent from extensive comparative study that less difference in size and shape exists between the spores of *D. minutum* and some typical strains of *D. mucoroides* than between certain strains which unquestionably belong together in the latter species. The striking similarity between the spores of the two slime molds is shown in figure 4.

MYXAMOEBAE

Spore germination in *Dictyostelium minutum* is accomplished, as in other species of the Dictyosteliaceae, by a longitudinal splitting of the spore case followed by an emergence of the spore content as an amoeboid protoplast, or myxamoeba. During the ensuing vegetative period the myxamoebae vary appreciably in size

and differ even more markedly in shape, depending upon whether they are quiescent, feeding, or actively moving.

Quiescent myxamoebae are typically rounded in form and show few or no pseudopodia. Ectoplasmic and endoplasmic zones cannot be distinguished in such individuals normally, nor is a contractile vacuole generally evident. The nucleus may or may not be distinguishable in unstained individuals. The bodies of such rounded myxamoebae range from $8\,\mu$–$10\,\mu$ in diameter with the majority measuring approximately $9\,\mu$. Individuals, however, not infrequently exceed this range, and often fall below $8\,\mu$ in diameter.

When actively feeding upon relatively scattered bacterial cells, the myxamoebae of *Dictyostelium minutum* vary greatly in shape and in apparent dimensions but commonly range from $7\,\mu$–$10\,\mu \times 12\,\mu$–$18\,\mu$. Furthermore, their shape is constantly changing as the direction of movement is shifted and as pseudopodia are extended and retracted. Commonly, however, the myxamoebae appear roughly triangular in form, the body being broadened along the advancing front and tapering more or less abruptly toward the area of the contractile vacuole which characteristically occupies a posterior position. In contrast to quiescent individuals, ectoplasmic and endoplasmic areas are clearly distinct. The former usually appears as an irregular, non-granular crescent-like band, extending across the anterior part of the body and thinning rapidly along either side. Extensions of the ectoplasm in the form of pointed pseudopodia are not uncommon and feeding is frequently facilitated by such projections. Usually the entire anterior surface acts as a feeding front and bacteria are ingested simply by the invagination of the body membrane. Whereas bacteria can apparently be ingested at any point on the body surface, feeding occurs primarily along the anterior of the body, possibly because as the myxamoeba advances this area in particular contacts large numbers of bacterial cells. The bulk of the amoeboid body consists of endoplasm which is hyaline and finely granular. This normally contains, however, some coarser granules together with a number of more or less opaque food vacuoles inclosing bacterial cells in various stages of digestion. A single nucleus occupies a position near the center of the body. Commonly two or more contractile

vacuoles are observed in the same individual but they regularly merge before being discharged. The movement of actively feeding myxamoebae is relatively slow and apparently at random for their direction is almost constantly changing. Rapidly moving individuals, on the other hand, are commonly limax-shaped, and a uniform direction of movement may persist for appreciable periods. Feeding by such elongate myxamoebae is much reduced. Going a step further, feeding ceases altogether as the myxamoebae become increasingly elongate, 7 μ–8 μ $\times$ 18 μ–24 μ, at the time of initiating the fruiting phase.

The feeding habits of the myxamoebae of *Dictyostelium minutum,* like those of *D. discoideum* (Raper, 1937), can be studied most satisfactorily by growing the slime mold in association with *Bacillus megatherium.* As in the case of *D. discoideum* the spores of the bacillus are not digested.

PSEUDOPLASMODIUM FORMATION

The specific characters of *Dictyostelium minutum* begin to appear with the initiating of the fruiting phase. Whereas the myxamoebae are seemingly alike in this slime mold and in other species, marked differences in their behavior become obvious in the early stages of aggregation. In thin cultures such as those resulting when the slime mold is cultivated upon weak peptone or dilute hay-infusion agar, the myxamoebae of *D. minutum* normally become oriented toward definite centers of aggregation, but the resulting organizations are regularly much smaller than in other species of the genus, *viz. D. mucoroides, D. purpureum,* and *D. discoideum.* Pseudoplasmodia of this type are shown in figure 1, *E* and *F,* and, except for their diminutive size, suggest the pseudoplasmodia of the larger species. The maximum diameter of these pseudoplasmodia rarely exceeds 1.5 mm. in contrast to 1 cm. or more for the larger species. Furthermore, under conditions most favorable for the development of radiate pseudoplasmodia, many organizations reveal this pattern imperfectly or not at all. Frequently pseudoplasmodia consist of sheet-like masses of myxamoebae flowing towards aggregation centers rather than of definitely converging streams (FIG. 1, *C* and *D*). Less

commonly, aggregates fail to show definite centers and the myxamoebae comprising an apparently single pseudoplasmodium do not show uniform orientation toward any particular point of convergence. This condition is clearly illustrated in figure 1, *G*. In such pseudoplasmodial masses, however, one or more definite centers subsequently appear and toward these the myxamoebae converge.

In dense cultures such as result upon hay-infusion agar when the slime mold is cultivated with *E. coli,* aggregation is not accomplished by the inflowing of even poorly accentuated streams of myxamoebae. It is effected instead by the blocking out of masses of myxamoebae and the subsequent emergence from these of small and, for the most part, typical fruiting structures as shown in figure 2. This is of particular interest, for the phenomenon is essentially comparable to that described by the writer for *D. discoideum* and other large species when these are cultivated upon much richer substrata (**1940b**). In the general pattern of the organizations established, pseudoplasmodium formation in *D. minutum* upon quarter-strength hay-infusion agar is comparable to that of *D. mucoroides* upon full-strength hay-infusion agar; whereas pseudoplasmodium formation in *D. minutum* upon full-strength hay-infusion agar is comparable to that of *D. mucoroides* upon media containing 1.2 per cent each of peptone and some sugar fermentable by the associated bacteria (Raper, **1939**). A possible explanation for this behavior is suggested. The number of *D. minutum* myxamoebae that can effectively coöperate in fruit formation is less than the number than can similarly coöperate in a large species such as *D. mucoroides*. In addition, for each species there exists a definite relationship between the quantity of myxamoebae that can coöperate in fructification and the richness of growth at which pseudoplasmodia of radiate form give way to pseudoplasmodia of block-form. Similar patterns of aggregation thus occur upon relatively poor media in a species characterized by small pseudoplasmodia and upon rich substrata in a species characterized by large pseudoplasmodia. Nevertheless, the general conduct of the two slime molds is basically the same. Apparent differences in their behavior and development during the fruiting process result only

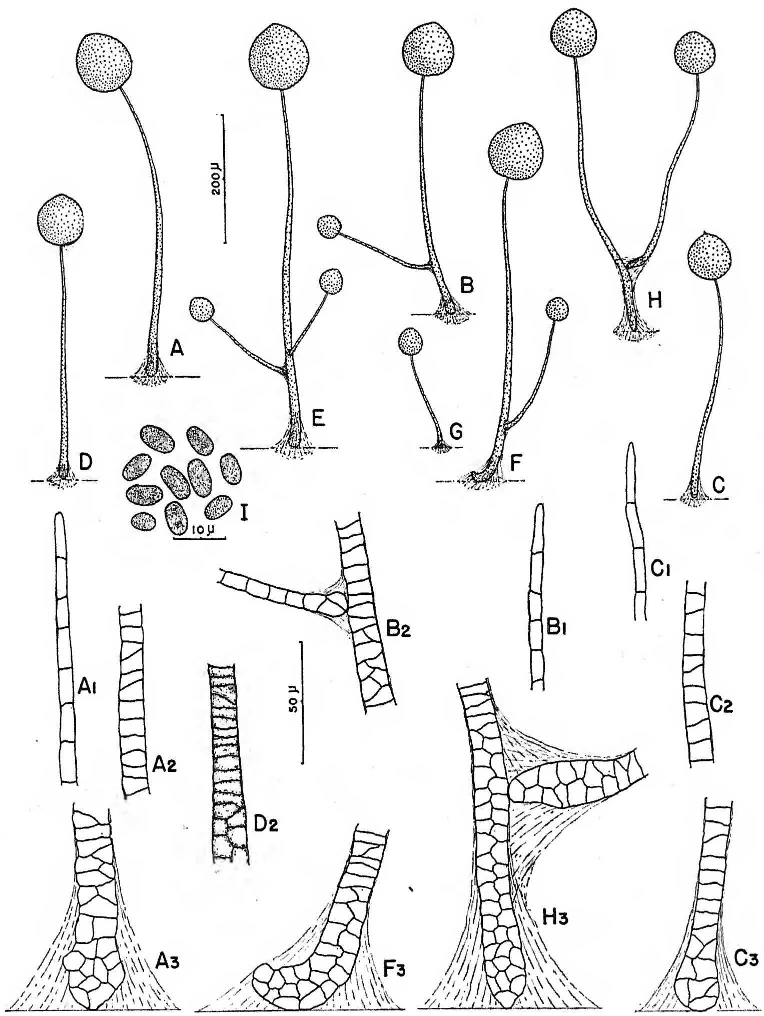

FIG. 3. Mature sorocarps of *Dictyostelium minutum*. *A–G*, camera lucida sketches of typical sorocarps showing relative proportions. A_1, A_2, and A_3, cellular structure of terminal, central, and basal portions of sorocarp *A*. B_1, terminal portion of sorocarp *B*. B_2, structure and anchorage of branch in same sorocarp. C_1, C_2, and C_3, apical, central, and basal portions of sorocarp *C*. D_2, detail of cellular structure near sorophore base, sorocarp *D*. F_3, recurved base of sorocarp *F*. H_3, detail of branch anchorage in sorocarp *H*. *I*, spores. Scale variable as indicated.

from the different quantity of myxamoebae involved in the fruiting organizations of the two species.

The pseudoplasmodia have no migrating stage such as characterizes *Dictyostelium discoideum* (Raper, 1935). Sorocarps are invariably developed at the sites of pseudoplasmodium formation.

SOROCARPS

The characters which distinguish *Dictyostelium minutum* as a species attain their full expression in the development of the mature fructifications, or sorocarps. Typically, a sorocarp consists of a short, tapering, upright stalk, or sorophore, bearing at its apex a colorless to milk-white spore head, or sorus, of comparatively large size. The sorophore rises vertically into the air and is, as a rule, securely anchored to the substratum by abundant slime, which in effect acts as "guys" to hold the entire body in an upright position (FIG. 3). The sorocarp may be either simple or "branched" (FIG. 3), and fruiting structures of the latter type are much more common in this than in other species of *Dictyostelium*. There is no regularity either in the dimensions or placement of branches. Furthermore, in its pattern and in the manner of its anchorage each individual branch can be considered as an independent sorocarp, usually, but not always, of reduced size (FIG. 3, *H*). Primarily, it differs from a solitary sorocarp in that it derives anchorage and support from another sorocarp rather than directly from the substratum.

Dictyostelium minutum differs from other species of the genus particularly in the dimensions and pattern of its sorophores. Under optimum cultural conditions these are characterized by a marked but gentle taper as illustrated in figure 3. They occasionally attain a millimeter in length but usually fall within the range from 550 μ–850 μ. Smaller structures are not uncommon. In their somewhat swollen basal portions, sorophores are normally 12 μ–20 μ in diameter and commonly two or three cells thick. Stalk bases four cells in thickness are relatively rare but not abnormal. Typically, the cells of the basal area are irregular in shape and parenchyma-like. Just above the basal area the sorophore commonly narrows to 10 μ–15 μ in diameter and is usually

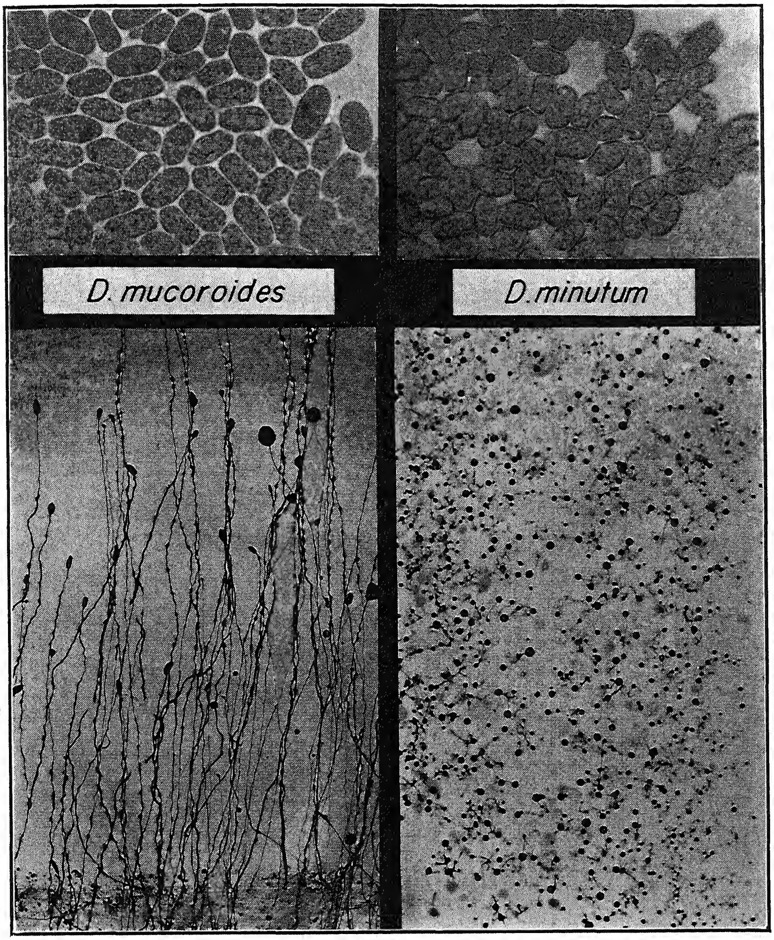

FIG. 4. Comparative size and pattern of spores and sorocarps of *Dictyostelium minutum* and *D. mucoroides*. Cultures grown under identical conditions in association with *Escherichia coli* upon hay-infusion agar in one-sided illumination. Spores of each species × 1000. Sorocarps of *D. mucoroides* × 3.6; sorocarps of *D. minutum* × 7.2.

one or two cells in thickness. When arranged in a single tier the cells of this portion of the stalk are characteristically disk-shaped and horizontally flattened (FIG. 3, D_2). In their central area stalks commonly range from $7\,\mu$–$10\,\mu$ in diameter and normally consist of a single row of more or less isodiametric cells. In their terminal regions such stalks consist of a tier of vertically

elongate cells, commonly 3 μ–5 μ in diameter and 15 μ–10 μ in length.

Compared with the more common species of the Dictyosteliaceae, the sorocarps of *Dictyostelium minutum* are extremely delicate (FIG. 4). Nevertheless, they are regularly characterized by comparatively large sori that commonly range between 75 μ–125 μ in diameter and may occasionally reach 150 μ. The brevity and thinness of the sorophores, as noted above, coupled with the relatively large dimensions of the spore masses lend to the sorocarps of this slime mold a striking and distinctive pattern (FIG. 1, *H* and *I*). Once its sorocarps have been observed in culture the slime mold is unmistakably distinguishable from the more common species of the genus.

As in other members of the group, the sorus consists of a large number of spores suspended in a small droplet of fluid expressed from the myxamoebae during their maturation into spores. The whole mass hangs from the apex of the sorophore. The manner in which it is borne accounts for the somewhat tear-drop shape of the sorus.

The above description is based primarily upon solitary sorocarps characteristic of thin cultures, but it likewise covers adequately stalk and sorus patterns of clustered sorocarps. In the writer's experience, under optimum cultural conditions, clustered sorocarps differ from solitary structures primarily in being more frequently branched.

DISCUSSION

Two small species of *Dictyostelium* characterized by white spore heads have been previously reported, namely: *D. lacteum* van Tieghem (**1880**) and *D. brevicaule* Olive (**1901**). The description of neither species adequately pictures the slime mold under consideration. *Dictyostelium lacteum* was depicted as possessing stalks consisting of a single tier of cells, a character that is strongly suggestive of *D. minutum*. However, sorocarp dimensions were not given, and its spores were reported as spherical and very small, 2 μ–3 μ in diameter. Myxamoebae giving rise to such small spores would undoubtedly differ markedly from those of *D. minutum*. *Dictyostelium brevicaule* was described as characterized by

short and rather heavy stalks bearing comparatively large sori. The latter character is remindful of *D. minutum,* but the stalks of this slime mold when grown under favorable culture conditions are anything but rigid. In addition, the sorocarps of *D. brevicaule* were described as ranging from 1–3 mm. high and therefore definitely larger than those of *D. minutum.* In the writer's experience strains possessing the characters of *D. brevicaule* have been occasionally isolated. While there is some question whether this represents a separate species or a short stalked variation of *D. mucoroides,* there is no question but that it is definitely different from *D. minutum.*

In the size and pattern of its spores and in the appearance and behavior of its vegetative myxamoebae, *Dictyostelium minutum* bears a striking resemblance to the exceptionally common species, *D. mucoroides.* The fruiting structures of the two slime molds, however, are markedly different, and it is this difference which sets them apart as distinct species. It is important to note that the distinguishing characters in this case arise not from apparent morphological or physiological differences between the myxamoebae which constitute the basic units in the two organisms, but rather from the way in which these units organize and differentiate to effect fructification. The limited number of myxamoebae that can effectively coöperate in building a sorocarp of *D. minutum* is an inherent and specific character of the species. Likewise inherent and specific is the particular way in which the myxamoebae differentiate to produce a diminutive fruiting structure characterized by a short, thin tapering stalk supporting a comparatively large spore head.

In *Dictyostelium minutum,* as in *D. mucoroides* and *D. purpureum,* sorocarp formation is normally initiated by the time the aggregation of myxamoebae comprising the pseudoplasmodium is completed. Unlike these species, however, *D. minutum* invariably builds its sorocarps directly above the sites of myxamoebic aggregation. In side-illumined cultures of the larger species one commonly finds a sorus borne as much as 5 cm. from the center of pseudoplasmodium formation, the intervening distance being bridged by a continuous and for the most part horizontal stalk of fairly even diameter. In *D. minutum* there is no comparable

light response. In fact, in repeated experiments the writer has been unable to detect any consistent response to light. Two possible explanations of this behavior present themselves. The pseudoplasmodium and young sorocarp of this species, unlike other members of the Dictyosteliaceae, may be basically insensitive to light. On the other hand, the young sorocarp may be of such small dimensions, or the stage of functional differentiation may be so advanced at the close of aggregation, that light sensitiveness, though present, cannot gain expression. While *D. mucoroides* and *D. purpureum* are generally considered to be extremely sensitive to light (FIG. 4), developing sorocarps less than 5 or 6 mm. in length do not normally show a marked phototropic response. In view of this behavior the absence of an evident phototropic response is not surprising when it is recalled that the sorocarp of *D. minutum* rarely exceeds a millimeter in height.

SUMMARY

A new species of *Dictyostelium* isolated from forest litter is described. Because of the diminutive character of its sorocarps the name *D. minutum* is proposed.

In the size and pattern of its spores and in the behavior of its vegetative myxamoebae in culture, the species closely resembles *D. mucoroides*. It is distinguished from this species primarily by the conspicuously smaller dimensions of its pseudoplasmodia and sorocarps and secondarily by the pattern of its completed fructifications. In thin cultures under optimum environmental conditions, radiate pseudoplasmodia appear, but they are not formed as consistently as in the larger species. Mature sorocarps are diminutive and unsubstantial. Typically they consist of short, thin, tapering sorophores bearing comparatively large, colorless to milk-white sori. Normally the sorophore consists of a single tier of cells throughout the greater portion of its length, the individual cells varying in shape from flattened and discoid toward the base to elongate and tube-like at the apex. Branched sorocarps are more common than in any other species of *Dictyostelium*.

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PEORIA, ILLINOIS

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DISCHARGE OF THE SPORANGIOLES OF BIRD'S NEST FUNGI

B. O. Dodge

(with 2 figures)

In a recent number of Mycologia[1] W. H. Diehl has discussed briefly the evidence in support of the idea that the fruiting bodies of *Leptostroma Camelliae,* reported by Zenker on the underside of leaves of *Camellia,* are, in fact, the sporangioles or peridioles of some member of the *Cyathus* group. The attachment of the sporangioles to the leaves as figured by Diehl is clearly not the only way they may be attached. Mr. John J. Shea several years ago called my attention to the fact that the sporangioles of species of *Cyathus* often hang suspended to leaves by the funicular threads, which may vary in length up to two or three inches. I recently received a letter from this gentleman in which he says that for twelve years or more he has made a study of species of *Cyathus* and related genera and has seen many times the sporangioles of four different species attached to leaves by long thin threads or funiculi which he referred to as the "web." He points out that the fungus shoots the sporangioles into the air and that they can be found attached to leaves, twigs and limbs of willows, scrub oaks, or whatever plants are growing near the developing cups or basidiocarps. As to the distance the sporangioles are shot, he says: "I find some as high as 13 feet, some 10 feet and all the way down to a few inches from the ground. By actual measurement I found some attached to leaves of a scrub oak which were 13 feet above the ground." He says he grew the plants in the house in old cheese boxes and he discovered that the sporangioles were shot onto the window panes as well as up under the awning. He tells me personally that they are shot out at night and not when the peridia are wet, but some time afterwards. He has recently shown me that the sporangioles of a species of *Crucibulum,* which

[1] Mycologia 33: 215–219. 1941.

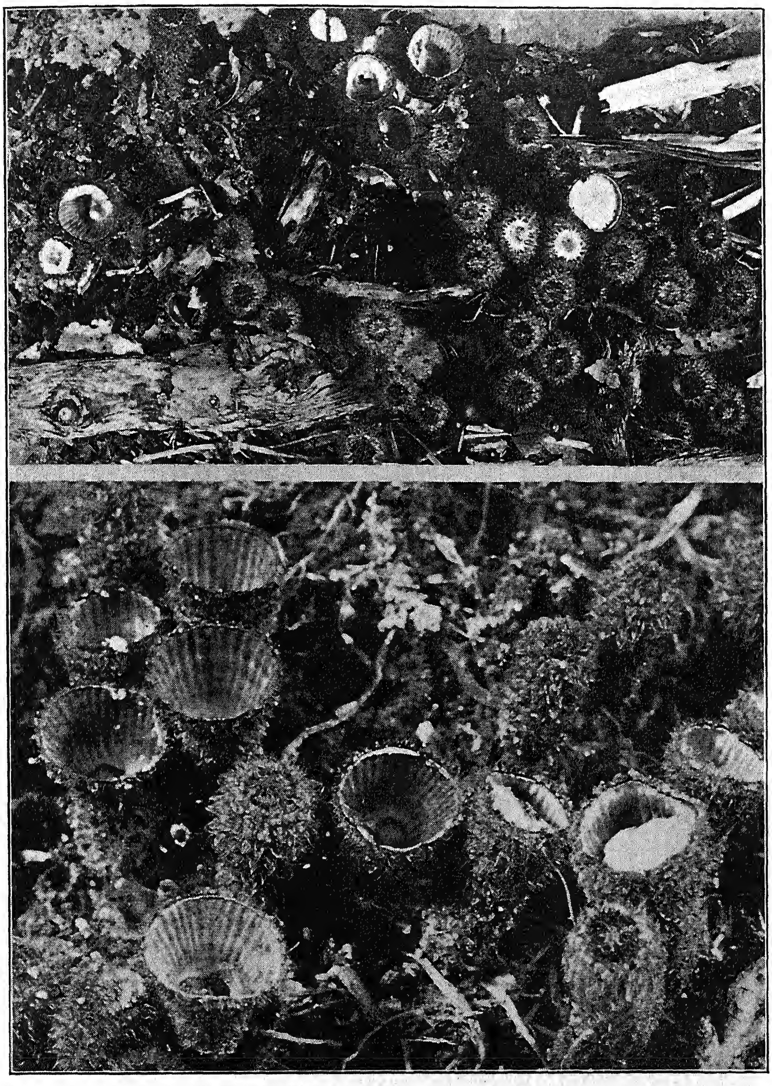

FIG. 1. Photographs of specimens of *Cyathus striatus,* located for the writer by Dr. F. J. Seaver. This group of basidiocarps was growing on decaying sticks and leaf mold, others were growing directly on coal ashes in the dump. Above, the mouths of most of the peridia are still closed. The snow-white epiphragm is clearly shown in several cases. Below, peridia are fully open.

has white peridioles and yellowish buff cups, may be found attached directly to the leaves and not hanging in the air. Some of them may be found on the lower side of the leaf, others on the upper side. As a rule, if one examines these attached sporangioles he finds a sort of a net or network attached to a short thread, but the morphological features here are quite different from those characteristic of species of *Cyathus,* which have a well organized funiculus from which a very long thread is spun out. When Mr. Shea first called my attention to this phenomenon of sporangiole discharge several years ago, I asked him to get in touch with A. H. R. Buller, which he said he did by letter. Buller's reply, Shea said, was rather noncommittal, at least he was not aware that the periodioles were discharged in this manner. Recently I have had the occasion to examine rather superficially the mode of attachment of the sporangioles of *Cyathus striatus* to the peridium. There is at the base of the funiculus a volva-like cup which is sometimes funnel-shaped and at others more or less cylindrical, composed of a web-like growth. This is attached firmly to the inside of the peridium. The peridiole with its rather short bulbous stalk resembles in miniature a sporophore of a *Boletus*. The bulbous base of the funiculus is attached by a thread to the volva sac either at a lower part or sometimes rather near the margin on the inside of the cup, in which case many very fine attachment threads are involved.

If one slits open the peridium and grasps a peridiole with a pair of forceps, holding the peridium with the other hand, he can see under a binocular dissecting microscope how the funicular thread is spun out as it unwinds and spins up and down and from side to side in the funicular sac, which is consumed during the process of spinning and which usually finally disappears, becoming a part of the thread itself. Depending somewhat on the state of maturity and the moisture of the cup and the way one handles the setup, the spinning process may begin either directly under the peridiole or down near the lower end of the funiculus. This is best observed when no free water is present. One is reminded, when he sees how the funicular thread can be pulled out rapidly without a break, of the way parachutes must be carefully packed or the life

saver's lines must be coiled, to insure against tangling at the critical moment.

The Tulasnes [2] long ago described and figured very beautifully this phenomenon of spinning out of the funiculus. They also figured rather accurately the various structures involved. They did not, however, observe that the peridioles were discharged with violence, neither did Sachs,[3] who studied *Crucibulum*. The Tulasnes evidently thought that the funicular thread was enclosed in

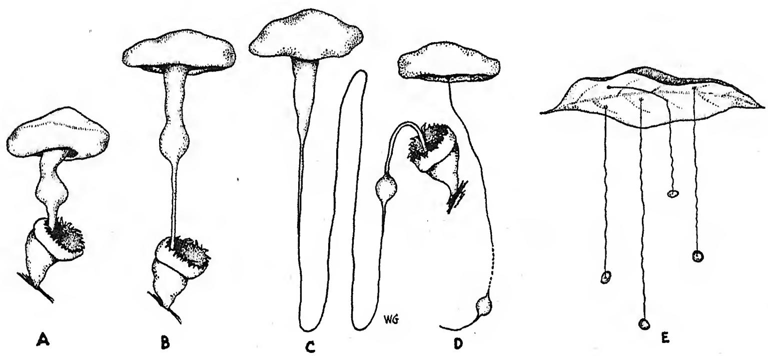

FIG. 2. Sketches showing (*a*) a lens-shaped peridiole with its stalk or funiculus having a bulbous end which is attached to the inside of the "volva"; (*b*) the attachment or anchor thread has been stretched out by pulling on the peridiole with a forceps; (*c, d*) the funicular thread has been spun out its entire length, which finally becomes three or more inches long before it breaks away. It may break directly at the bulbous end, or the anchor thread attaching the bulb to the "volva" may break. If the moisture content is just right, the thread begins to spin from directly beneath the peridiole; (*e*) sketch of a leaf showing three or four peridioles hanging by threads of different lengths.

a sac which was a distinct structure. The funicular thread, although very fine, is comparatively strong when dry. Even when moist it can hold a weight much more than the weight of a basidiocarp or peridium. It is difficult to imagine just how a pressure can be built up which will be sufficient to throw the peridioles 10 or 15 feet into the air. One finds these structures of *Crucibulum* attached to the upper side of the leaves as well as the lower side,

[2] Tulasne, L. & Tulasne, C. Ann. Sci. Nat. III. **1**: 41–107. *pl. 3–8*. 1844.
[3] Bot. Zeit. **13**: 849. 1855.

showing that they must have been originally shot higher than the leaves themselves in order to fall on the upper surface. The whitish peridioles of a *Crucibulum* are usually attached to the leaf by the lower surface of the peridiole and not infrequently a short white thread extends out from the peridiole along the leaf to which it sticks. There is frequently a web-like growth attached to the thread. No doubt those peridioles which are provided with a definite funicular structure often hang down from leaves by the thread which may shorten or lengthen depending on the moisture.

We placed the specimens shown in the photograph under a bushy *Amelanchier,* early in August. By September 1st there were quite a number of the peridioles hanging from the under side of the leaves, the threads varying from one-half to three inches in length. The short threads represent cases where the greater length of the thread is stuck to the leaf, only a short part being free. Several peridioles were attached directly to the under side of the main stems which stand at about a forty-five degree angle. The peridioles themselves are loose, however, and not stuck to the bark as would first appear. The thread can be seen stuck to the bark for its entire length. Wetting the bark often releases the thread sometimes only for a part of its length so that the peridioles hang down normally.

THE NEW YORK BOTANICAL GARDEN

SOME LEAF SPOT FUNGI ON WESTERN GRAMINEAE [1]

RODERICK SPRAGUE [2]

(WITH 1 FIGURE)

The fungi discussed in this article represent incompletely known or undescribed species that may be encountered by workers dealing with diseases of western range and pasture grasses. The collections that are mentioned in this note are filed either at Oregon State College (O.S.C. numbers) or are in the Mycological Collections of the Bureau of Plant Industry, U. S. Department of Agriculture. The fungi will be discussed individually as follows:

Phyllosticta Owensii sp. nov.

Maculis elongatis, griseis; pycnidiis sparsis, globosis, erumpenti-superficialibus, nigris, tarde ostiolatis, 70–100 μ, pycnosporulis numerosis, bacillaribus aseptatis, hyalinis 2.3–4.6 × 1.0–1.4 μ.

Hab. in foliis vivis et emortuis *Dactylidis glomeratae,* Waldport, Oregon. Sept. 24, 1939.

Lesions elongate, gray, pycnidia sparse, globose, superficially erumpent, black, tardily ostiolate, 70–100 μ; spores numerous, bacillar, non-septate, hyaline, 2.3–4.6 × 1.0–1.4 μ.

On living, dead or salt-spray-injured leaves of *Dactylis glomerata* across the Alsea River from Bailey's Landing, 3 miles east of Waldport, Oreg., and at Yaquina John Point, Waldport, Oreg. (Type, O.S.C. *8,000*). Associated with *Scolecotrichum graminis* Fuckel.

[1] Coöperative investigations between the Division of Forage Crops and Diseases and Cereal Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture, and the Oregon and North Dakota Agricultural Experiment Stations. Approved by the Director of the Oregon Agricultural Experiment Station for publication as Technical Paper 372, contribution from the Department of Botany.

[2] Pathologist, Division of Cereal Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture. The writer is indebted to A. G. Johnson and associates for aid in the preparation of this paper, and to Miss Edith Cash for checking the Latin descriptions.

This fungus has some resemblance to *Phyllosticta striolata* Sacc. (**11**, p. 45) on *Brachypodium distachyon* but differs from it in that the ostioles are smaller or sometimes absent and the spores and pycnidia are larger. The spores of *Phyllosticta Dactylidis* Gonz. Frag. (**1**) are not bacillar as in *Phyllosticta Owensii* but are ovoid to oblong, 3–5 $\times$ 2–3 μ and are therefore twice as broad as the latter.

Phyllosticta Owensii is placed in *Phyllosticta* instead of *Phoma* not because it occurs on leaves (which is of no importance in itself) but because there seems to be considerable doubt as to the actual authenticity of the genus *Phoma*. *P. Owensii* has more of the appearance of the so-called *Phoma* group than of *Phyllosticta*. *Phyllosticta* is usually considered as having relatively thin-walled pycnidia with dark pigment only in the cells adjacent to the ostiole, while *Phoma* is typically recognized as having compact dark pycnidia, with strongly carbonized or colored walls, accompanied by stout ramifying mycelium in the substratum. Many of the *Phoma* species occur on woody parts, often as saprophytes (**3**) and this in itself induces dematiaceous tendencies in the pycnidial development. The common leaf spotting Phyllostictae on their more succulent substrata develop a paler, thinner-walled fruiting body and actually are fundamentally no different from their darker associates on woody or silicified host parts except as chance has given them different environments. *Phyllosticta Owensii* is weakly parasitic on leaves, and shows decidedly "*Phoma*-like" pycnidia, more so than the other species of *Phyllosticta* described or discussed in this article. In assigning this species to *Phyllosticta* we note that Grove (**3**) disparages those that use *Phoma* as a "dumping-ground" for ill-understood fungi. The same can be said for *Phyllosticta*, as continued study will no doubt show that many of these fungi have septate spores. Until the happy day when everything is known about all fungi, it seems necessary to assign these fungi with one-celled spores, borne in ostiolate pycnidia, to some genus and species. Except for a few overworked ones (cfr.: *P. sorghina*) there are relatively few species of *Phyllosticta* on Gramineae. It appears to be necessary, therefore, to describe three species of *Phyllosticta* in this article, including *P. Owensii* above noted.

Phyllosticta anthoxella sp. nov.

Pycnidiis erumpentibus, nigris, globosis, 35–50 μ, ostiolatis (4–5 × 10–12 μ), pycnosporulis bacillaribus, aseptatis, hyalinis, guttulatis 5–9 × 1–1.6 μ. Hab. in foliis dejectis *Anthoxanthi odorati.* Oregon.

Pycnidia scattered but tend to be in rows parallel to the leaf veins, erumpent, black, minute, 35–50 μ, ostiolate (4–5 × 10–12 μ)

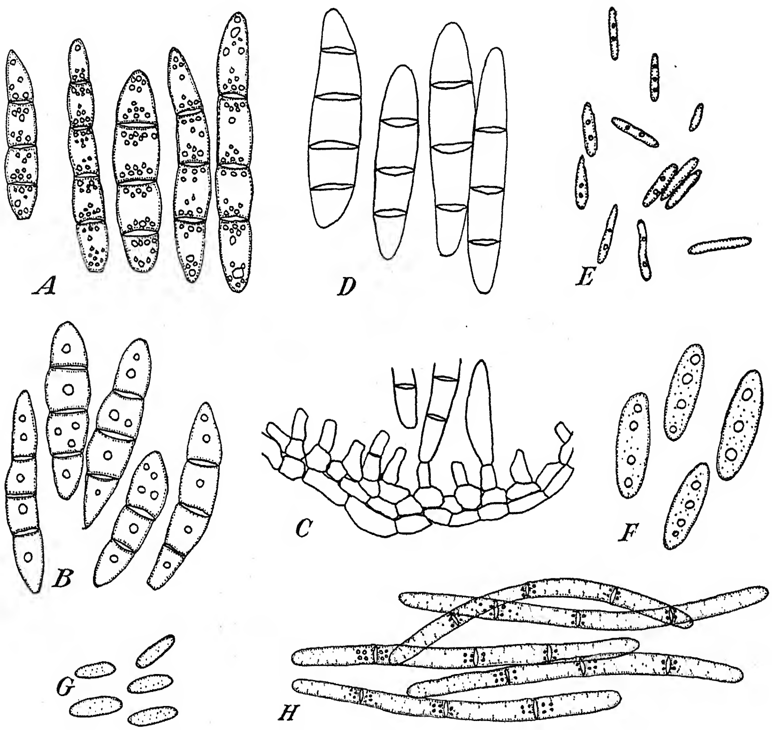

FIG. 1, *A,* pycnospores of *Stagonospora subseriata* (Desm.) Sacc. var. *maculata* Grove on *Dactylis glomerata,* State College, Pa., collected by S. J. P. Chilton; *B,* pycnospores of *Stagonospora subseriata* on *Elymus mollis,* Manhattan, Oreg., Aug. 16, 1939; *C,* cross section of pycnidial wall of *Stagonospora subseriata* var. *maculata* from State College, Pa.; *D,* pycnospores of *Stagonospora subseriata* on *Deschampsia caespitosa,* Lyndhurst, Hampshire, Engl., collected by Cooke; *E,* pycnospores of *Phyllosticta anthoxella* Spr. from type collection; *F,* pycnospores of *Phyllosticta Roglerii* Spr. from type collection; *G,* pycnospores of *Phyllosticta sorghina* Sacc. from *Setaria viridis,* Langdon, N. Dak., Aug. 2, 1940; and *H,* pycnospores of *Septoria Secalis* Prill. & Del. var. *Stipae* Spr. on *Stipa viridula,* from type collection. (All drawings made with the aid of the camera lucida. Magnification × 1,000.)

surrounded by darker, sepia-colored cells, pycnospores exuded in long chains in water mounts, hyaline, aseptate with 2 to several small guttulae, cylindrical or bacillar, 5–9 × 1–1.6 μ.

On dead basal leaves of *Anthoxanthum odoratum,* associated with *Colletotrichum graminicolum* and *Titae* sp. North shore of Triangle Lake, along highway, Lane county, Oreg., May 10, 1938 (Type, O.S.C. *264*).

There are no fungi on *Anthoxanthum* comparable to this except possibly *Septoria anthoxina* Gonz. Frag., which has considerably larger spores (25–30 × 1.2–1.5 μ), and the few species of *Phyllosticta* that approach *P. anthoxella* in spore dimensions. These latter, however, have much larger pycnidia. The spores of *P. anthoxella* are illustrated in figure 1, E.

Phyllosticta Roglerii sp. nov.

Maculis parvis, elongatis, albidis; pycnidiis conspersis flavo-brunneis, globosis, erumpentibus, ostiolatis (6–12 μ), parenchymaticis, 50–100 μ diam.; pycnosporulis ellipsoidis, aseptatis, hyalinis, guttulatis, 11–15 × 2.5–4.5 μ.

Hab. in foliis vivis *Digitariae sanguinalis.* Iowa.

Spots small, elongate, white, pycnidia scattered, yellow brown, globose, strongly erumpent, thin walled, composed of polyhedral cells, ostiolate (6–12 μ) 50–100 μ; pycnospores ellipsoid, non-septate hyaline, 3–6 guttulate, 11–15 × 2.5–4.5 μ (FIG. 1, *F*).

In living leaves of *Digitaria sanguinalis* (L.) Scop. associated with *Colletotrichum graminicolum* in fields near Albia, Iowa. Sept. 10, 1940. Collected by George Rogler and R. Sprague.

It is suspected that this species is a developing phase of a larger fungus.

PHYLLOSTICTA SORGHINA SACC. ON SETARIA VIRIDIS

The common weed and pasture grass *Setaria viridis* is affected with an eye spot type of leaf injury in the vicinity of Langdon, North Dakota. The lesions are irregular, mostly sub-circular, 3–8 mm. diameter, pale straw to isabelline with narrow purple borders. The pycnidia are small, 60–100 μ, black, sub-globose, fuligenous walled, strongly erumpent, but not mammiform. The spores are non-septate, hyaline, eguttulate, and exude in cirri when the pycnidia are placed in water. The spores are ellipsoid with rounded ends 4.5–6.5 × 2.1–2.5 μ (FIG. 1, *G*).

TABLE 1

COMPARISON OF *Phyllosticta sorghina* WITH RELATED SPECIES

Fungus	Host	Country	Pycnidia	Pycnospores
			μ	μ
P. sorghina Sacc. (9)	*Sorghum vulgare*	Italy	—	5×2
P. Sacchari Speg. (12)	*Saccharum officinarum*	Argentina	90–100	4–6×2–3
P. Setariae Ferr. (2)	*Setaria lutescens* (*S. glauca*)	Italy	110–120	6.5–7×2.5–3
P. glumarum-Sorghi P. Henn (4)	*Sorghum vulgare*	Congo	40–60	4–5×2–3
P. glumarum-Setariae P. Henn (4)	*Setaria lutescens* (*S. aurea*)	Congo	60–70	3.5–4×2–2.5
P. phari Speg. (13)	*Pharus glaber*	Argentina	50–75	4–5×2
P. Penicillariae Speg. (14)	*Pennisetum glaucum* (*Penicillaria typhoidea*)	Senegal	120–150	4–5×2
P. sorghina Sacc.	*Setaria viridis*	United States	60–100	4.5–6.5×2.1–2.5
Phoma insidiosa Tassi	*Sorghum vulgare*	Abyssinia	70–80	6×2–2.5

This fungus differs from the description of *Phyllosticta sorghina* Sacc. in not having 2-guttulate spores and is not associated with an *Ascochyta,* although it could and may be a stage of this genus. Otherwise the fungus on *Setaria viridis* from Langdon is the same as *P. sorghina* Sacc. and it is assigned to this species.

In this connection, a number of related species were compared particularly for range of sizes of pycnidia and pycnospores. This comparison is given in table 1. While there are some minor differences, yet these are not considered significant as far as species delimitation is concerned, and accordingly these species names are brought together under one species name, *Phyllosticta sorghina* Sacc. being the oldest, and the following synonymy is proposed:

PHYLLOSTICTA SORGHINA Sacc.	1878	(9, p. 140)
SYN:		
P. Sacchari Speg.	1896	(12, p. 239)
P. Setariae Ferr.	1902	(2, p. 18)
P. glumarum-Sorghi P. Henn.	1907	(4, p. 101)
P. glumarum-Setariae P. Henn.	1907	(4, p. 101)
P. phari Speg.	1910	(13, p. 337)
P. Penicillariae Speg.	1914	(14, p. 129)
Phoma insidiosa Tassi	1898	(18, p. 8)

Some of these, particularly *Phyllosticta Penicillariae, P. glumarum-Sorghi, P. Sacchari,* and *P. glumarum-Setariae,* sometimes at least, have lenticular rather than globose pycnidia. Otherwise they appear to belong to one species.

"*Phyllosticta Sorghi* Anzi," referred to by Saccardo (9) in describing *P. sorghina,* is an older name than *P. sorghina* but it was not validly established because no pycnidia nor spores were described.[3]

The name "*Phyllosticta Sorghi* n. sp." was originally applied by Rabenhorst in 1876 (7, No. *2162*) to specimens showing characteristic leaf spots on *Sorghum saccharatum* collected by M. Anzi in northern Italy. With the exsiccati specimen, Rabenhorst gave no description either of the spots or of any fungus. In 1876, Raben-

[3] The discussion of *Phyllosticta Sorghi* Rab. is by A. G. Johnson who very kindly traced material and literature available in the Bureau of Plant Industry, Washington, D. C.

horst (**8**, p. 120), in commenting on the exsiccati specimen, referred to the name, properly, as "*Ph. Sorghi* Rabh." and noted that no description was given. In 1878, Saccardo (**9**), in describing *P. sorghina*, referred to the name as follows: "*Phyll. Sorghi* Anzi in Rabh. F. E. n. 2162 sistet forman leptostromaceam v. phyllachoraceam, cujus sporas proprias non vidi." In 1883, Thümen (**19**, No. *2196*) distributed more of apparently the same material collected by M. Anzi. His label reads as follows: "2196. *Phyllosticta Sorghi* Anzi in Rabh. Fung. europ. No. *2162*. Lombardia: Como in foliis vivis *Sorghi saccharati* Pers. Com. Dr. G. Winter. Leg. M. Anzi." The material is identical with that of the Rabenhorst No. *2162*, and likewise shows neither pycnidia nor spores. Both Saccardo and Thümen erred in ascribing the species name to Anzi, who was but the collector. As pointed out by Rabenhorst (**8**), the name was first applied in print by him, and if referred to, should be written: *P. Sorghi* Rabh.

In 1884, Saccardo (**10**, p. 65) transferred the still unestablished species name "*P. Sorghi*" to the genus *Depazea*, making the combination "*Depazea* (*Phyllosticta*) *Sorghi* Anzi," denoting that no spores had been found. Here Saccardo referred to "Hedwigia 1876, p. 120" and to "F. eurp. n. 2162" in neither of which Anzi is given as the authority for this unestablished species name. Here also Saccardo described the spots more adequately and added another host, namely, *Sorghum vulgare*, and added: "peritheciis —nullis visis." Thus the name was still a *nomen nudum* as there was no description of the fungus.

Oudemans (**5**, p. 709; 712) lists "*Phyllosticta Sorghi* Anzi" as a synonym for *Depazea Sorghi* Sacc. (Syll. Fung. **3**: 65) on *Sorghum saccharatum* and *S. vulgare*, also without any description of the fungus. Thus he wrongly cites Saccardo and Anzi as the authorities for the species name.

It seems clear, therefore, that the species name of *Phyllosticta Sorghi* Rabh. is non-available as it has never, so far as known, been validly established.

The symptoms on *Setaria viridis* as they occur at Langdon are confusable in the field with common bacterial spots on millets and species of *Sorghum*.

PHYLLOSTICTA SORGHINA SACC. ON TRICHOLAENA ROSEA NEES

Fragmentary material collected on *Tricholaena rosea* (Natal grass) at Pullman, Wash., in 1940, was sent to the writer by George W. Fischer. This material has spores identical in size ($5–6.5 \times 2.1–2.7 \mu$) with those on *Setaria viridis* as above discussed. The light colored spots with narrow red borders appear typical for the species. The pycnidia were brown, sub-superficial, ostiolate, globose, $50–90 \mu$ in diameter. Since this grass is closely related to *Setaria,* it appears reasonable to assume that infection on this exotic host probably developed as a result of association with local *Setaria viridis.*

STAGONOSPORA SUBSERIATA (Desm.) Sacc.

This species which was first described on *Enodium coeruleum* has broadly fusiform, mostly triseptate spores, which are constricted or sometimes not constricted at the septa. The type has spores $38–40 \times 7 \mu$. A collection on *Elymus mollis* from Manhattan, Oreg., has spores somewhat smaller, $20–33 \times 4.5–5 \mu$ (FIG. 1, *B*), but they are apparently immature ones of *S. subseriata* (compare with FIG. 1, *D*). The almost boat-shaped spores are quite distinct from *Stagonospora arenaria* Sacc., which also occurs on *Elymus* in the region (16). Similar material of *S. subseriata* was collected on *Elymus mollis* at Yaquina John Point, Waldport, Oreg., Sept. 24, 1939 (O.S.C. *732*).

Grove has proposed *Stagonospora subseriata* var. *maculata* on *Dactylis glomerata* (3), which has the pycnidia arranged in lines in blackish-brown blotches. Specimens of what seems to be this fungus on *D. glomerata* from State College, Pa., sent by S. J. P. Chilton, show similar symptoms and spores which are fusiform, 3–4 septate, yellow with coarse contents (FIG. 1, *A*), and $27–40 \times 4.8–6.5 \mu$, mean size $33 \times 5.5 \mu$. They are borne in globose golden brown pycnidia with walls about 5μ thick (FIG. 1, *C*). The cylindrical pycnophores are $4–6 \times 1.8–2.2 \mu$. The writer was of the opinion at first that this fungus must be a stage of *Stagonospora arenaria* because of similar symptoms and because *Dactylis glomerata* is a host for *S. arenaria* in Oregon (16) and Ohio. However, because of the decidedly different spores of the Penn-

sylvania material, there is no close genetic relation between the two. The writer therefore concludes that Chilton's material is the same as that described by Grove. Further study with more material of *S. subseriata* proper will be needed to determine finally if the definitely parasitic variety on *Dactylis* belongs with the weakly parasitic species proper. Along this line Gonzalez Fragoso (**1**) considers *S. subseriata* to be a phase of *Hendersonia culmicola*. Petrak (**6**, p. 383) lists a fungus on culms of *Dactylis glomerata* as *S. subseriata* (Desm.) Sacc. and states that the spores are 23–44 $\times$ 3–6 μ. Finally it should be noted that some collections of the boat-shaped-spored *S. subseriata* show little or no constriction at the septa (FIG. 1, *D*) while others show definite constrictions (FIG. 1, *B*). This is partly explained by the condition of the collections and the age when collected and probably does not represent particularly wide variations.

ROBILLARDA AGROSTIDIS Spr.

Following heavy rains, saprophytic material of *Robillarda Agrostidis* on *Buchlöe dactyloides* (Nutt.) Englm. was collected at Fargo, N. Dak., Sept. 5, 1940. The spores with their tri-furcate appendages were 17–22 $\times$ 1.9–2.3 μ, only slightly narrower than the winter material originally described on *Agrostis tenuis* from Oregon (**15**).

CONIOTHYRIUM PSAMMAE Oud.

Coniothyrium Psammae Oud. produces large, elliptical, light buff lesions with prominent vinaceous borders on living leaves of *Calamagrostis nutkaensis* (Presl) Steud. along the coast of Oregon. The few black pycnidia contain hyaline, later brown, elliptical spores 10–13 $\times$ 3–4 μ. They are produced by budding from the walls of the unilocular pycnidia on pycnophores, which vary from mere papillae to ones 6 μ or rarely 10–12 μ long. The spores have a slight hilum near one end and contain large, curved, central bodies or nuclei.

On the basis of size and morphology of spores, this fungus belongs in *Coniothyrium* rather than *Sphaeropsis*. The earliest recognizable name appears to be *Coniothyrium Psammae* Oud.

It might be added that material of *Coniothyrium Psammae* collected near Taft, Oreg., on March 25, 1933, had a species of *Mycosphaerella* associated with it (O.S.C. *10,817*) although other material from Waldport, Oreg., collected March 22, 1937 (O.S.C. *749*) did not show any *Mycosphaerella.* The asci from the Taft collection were cylindrical, 50 × 11–13 μ and contained immature spores 17–20 × 5–6 μ.

Septoria Secalis Prill. & Del. var. Stipae var. nov.

This fungus causes a white leaf spot on *Stipa viridula* Trin. in southeastern South Dakota. The material collected at Vermillion in mid-September, after heavy rains, gave indications that the fungus was a very active parasite under such moist conditions. Comparison with all available fungi indicates also that this collection is referable to a variety of *Septoria Secalis* Prill. & Del. in that symptoms are very similar to and the spores are the same general shape as those on rye. This variety described on *Stipa viridula* differs in having longer spores (those on rye are 25–50 × 2.5–3.5 μ), somewhat more prominent pycnidia, and in having spores with less homogeneous contents. The latter character may not be of any importance as the Vermillion material may not be entirely mature, as indicated by the glutinous nature of the oozing cirri.

The description is as follows:

Lesions at first dark brown, circular, soon pale buff in center, finally white to gray-white and elongate; pycnidia prominent, black, globose, 130–190 μ, ostiolate, erumpent; pycnospores sometimes straight but usually slightly and stiffly curved, broadly filiform with rounded and only slightly tapering ends, 3-septate with 2, 4, or several small oil drops on either side of the cross walls, rarely slightly constricted at the septa, 37–54 × 2.6–3.1 μ, oozing out from the pycnidia in large cirri which retain their identity for some time in water (FIG. 1, *H*).

On leaves, culms and sheaths of *Stipa viridula* Trin. at the C.C.C. Camp and Soil Conservation Service Nursery at Vermillion, S. Dak., Sept. 14, 1940. Collected by Olaf Aamodt, Roderick Sprague, and George Rogler (B.P.I. *80,012*).

This fungus is very distinct from *Septoria stipina* Died., which the writer reported elsewhere on *Stipa columbiana* var. *Nelsonii* from a collection made by W. E. Lawrence in the Blue Mountains in Oregon (17). *Septoria stipina* from Oregon has very narrow spores, 39–63 × 0.8–1.1 μ.

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NOTES AND BRIEF ARTICLES

The Devil and the Deep

In my work with the polypores, when I tried to break up a large homogeneous group into convenient pieces there was a terrible howl about the lack of generic characters, which I must admit was partly justified. In the boletes I used the color of the spores to segregate genera, as was commonly done with other fleshy fungi. Now this treatment draws heavy fire because *no one had thought of it before,* and also because I did not split the eighty species into ten genera of exactly eight species each! Sorry, but there seems to be no pleasing all the people all the time.—W. A. Murrill.

Correction—The host of the *Septoria,* described in Mycologia **33**: 362. 1941, is, *fide* Dr. A. J. Sharp, not *Tussilago* but *Cacalia atriplicifolia.* This material agrees exactly with what was collected by Demetrio in Missouri and issued as *Septoria Cacaliae* Ellis & Kellerm. by Kabat and Bubak in their Fungi Exsiccati, No. *417.*—John Dearness.

Lepiota Morgani, an Unwholesome Fungus

A case of toadstool poisoning has come to our attention which occurred in Riverside, California, in 1936. About two pounds of an agaric were gathered in the lawn and were eaten by four adults. Four hours after the meal symptoms were noted and were severe for two hours with traces for 24 hours. Symptoms consisted of nausea, cramps, and diarrhea. Two of the persons (women) who ate the mushrooms were severely affected; one man was mildly affected, and one man not affected.

The mushrooms were prepared by sauteing in butter. The specimens used were not seen by a mycologist but other specimens recognized by the users as identical were brought to the Citrus Experiment Station and were clearly *L. Morgani* (Peck) Sacc.

Lepiota Morgani occurs frequently in lawns in Riverside during warm weather and is of general distribution in southern California.[1] It evidently should be avoided as food.—WM. T. HORNE AND IRA J. CONDIT.

MONOGRAPHS OF THE PYRENOMYCETES

A sequel to Wehmeyer's monograph of *Diaporthe* and its segregates has recently appeared in the University of Michigan Studies, Science Series, volume 14. The latest monograph is devoted to the genera *Melanconis, Pseudovalsa, Prosthecium* and *Titania,* and their allies.

In his introduction the author comments on the duel purposes of a classification, i.e. to show natural relationship and to offer a convenient arrangement, and stated that often the latter is overlooked although in his opinion it is often the more important of the two. He explains that in this group it is often impractical to use conidial stages as a bases for segregating genera, because of the obscurity of this stage. If it were so used we still have a large number of forms to deal with in which the conidial stage is unknown, and an attempt to so use it would only add to the confusion already existing.

The monograph, consisting of 161 pages, is illustrated with eleven plates. The drawings are neatly done and well reproduced. The appearance is marred, however, by the fact that the plates do not fit the page. The work represents the result of years of study on the Pyrenomycetes of North America.—FRED J. SEAVER.

Respecting descriptions in Latin.—Under this heading Dr. Dearness, in the July–August number of Mycologia, criticizes the rule requiring descriptions of new groups to be in Latin or accompanied by a Latin diagnosis. His objections are: that English is almost universally understood; that the Latin description should contain everything that is in the vernacular description and hence the practice is wasteful of space; that the Latin language does not contain words adequate to express the concepts involved.

[1] Smith, Clayton O. *Lepiota Morgani* in Southern California. Mycologia **28**: 86. 1936.

It may be granted that English is intelligible to practically all interested in these matters; so are German and French and, to a somewhat less degree, Spanish, Portuguese and Italian. But what about Finnish, Czech, Polish and Russian, to say nothing of Japanese, Chinese and Hindustani? Surely, the writing of a brief Latin diagnosis is a small price to pay for relief from the necessity of recognizing new groups in all of the many vernaculars in which descriptions might be written were this rule to be generally disregarded. With the strong nationalistic feelings prevalent in the world just now, and likely to be more intensive, rather than less, in the immediate future, agreement on one, two or three of the great modern tongues is not possible with anything like the necessary approach to unanimity.

Need the Latin diagnosis contain everything in the vernacular description? The common practice, at present, is to give the essentials in Latin, and to elaborate upon these in the vernacular. The Latin diagnosis is enough for many purposes, and a very great help in the interpretation of the vernacular discussion when it is necessary that that be consulted. If this seems wasteful of space, an alternative, already used by some competent taxonomists, is available: a full and complete description may be written in Latin and the vernacular discussion omitted.

The argument that Latin words do not exist to express the concepts concerned is completely answered by the very existence of such works as the Sylloge Fungorum. Of course, they do not exist in classical Latin, but new concepts, and the Latin words to embody them, have been introduced into Latin from the days of the Church Fathers until the present. After all, Linnaeus, Fries, Montagne and, above all, the Tulasnes were able to express their ideas in Latin with as great precision and clarity as any of their contemporaries who wrote in their own languages. New concepts and new words in which to express them are still being introduced into taxonomic Latin. We may expect the descriptions of Dr. Dearness' new species to appear in accurate and wholly intelligible Latin, but, unfortunately, only after some years have elapsed. Dr. Dearness is quite right in supposing that this is of small moment when the original descriptions are in English, but it might be much

more serious as a source of future confusion were they in certain other languages.

It may be that the Latin requirement should be abandoned. If so, action to that end should be taken at a representative international congress, after full discussion and consideration. It would seem most unfortunate at a time like this, when the political structure of society is in such anarchy, for scientists to fail, even in so apparently trivial a way, to uphold the ideal of international coöperation, which has been a source of strength in the past and the promise of a better future.—G. W. MARTIN.

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1940–1941

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*REESE, E[LWYN] T[HOMAS], *Botany Department, Pennsylvania State College, State College, Pa.*

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ROBERTS, DR. JOHN W[ILLIAM], Principal Pathologist, Division of Fruit and Vegetable Crops and Diseases, *U. S. Horticultural Station, Beltsville, Md.* (Fruit diseases.)

ROGERS, DR. DONALD P[HILIP], Instructor, *Department of Botany, Brown University, Providence, Rhode Island.* (Cytology, comparative morphology, and taxonomy of the lower Basidiomycetes.)

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SALVIN, S[AMUEL] B[ERNARD], Assistant in Botany, *Biological Laboratories, Harvard University, Cambridge, Mass.* (Asexual reproduction in aquatic Phycomycetes.)

SATINA, MISS SOPHIE A., Cytologist, *Carnegie Institution of Washington, Cold Spring Harbor, N. Y.* (Cytology; experimental biology.)

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SAVULESCU, MRS. ALICE ARONESCU, *Institutul de Cercetari Agronomice, Bulev Mărăsti 61, Bucharest, Roumania.* (Plant pathology.)

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SMART, DR. ROBERT F[ORTE], Professor, *Department of Biology, University of Richmond, Richmond, Va.* (Physiology of the Myxomycetes; cytology of the Ascomycetes.)

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SPRAGUE, DR. RODERICK, Associate Plant Pathologist, U. S. Department of Agriculture, *Northern Great Plains Field Station, Mandan, N. Dak.* (Fungi Imperfecti on Gramineae.)

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STEVENSON, JOHN A[LBERT], Senior Mycologist in Charge, *Mycological Collections, U. S. Department of Agriculture, Washington, D. C.* (Taxonomy.)

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SWARTZ, DR. JACOB HYAMS, Associate in Dermatology, Harvard Medical School, *371 Commonwealth Ave., Boston, Mass.* (Medical mycology and dermatology.)

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TERVET, IAN W., Department of Plant Pathology, *University Farm, St. Paul, Minn.*

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THOMPSON, DR. GEORGE E[DWARD], Assistant Professor in Plant Pathology, *College of Agriculture, University of Georgia, Athens, Ga.* (Forest pathology and general mycology.)

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TOGASHI, KOGO, *The Morioka Imperial College of Agriculture & Forestry, Morioka, Japan.*

TORREY, G[EORGE] SAFFORD, Professor of Botany, University of Connecticut, *Storrs, R. F. D. 2, Conn.* (Intestinal fungi of Arthropods.)

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VAN VLOTEN, DR. IR. HEINRICH, Phytopathologist, *Instituut voor Phytopathologie, Laboratorium voor Mycologie en Aardappelonderzoek, Wageningen, Holland.*

VIEGAS, AHMÉS PINTO, *Instituto Agronomico, Campinas, Est. Sao Paulo, Brazil.*

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VOORHEES, RICHARD K., Associate Plant Pathologist, *Citrus Experiment Station, Lake Alfred, Fla.* (Citrus diseases and comparative morphology.)

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Walker, A[nson] R[obertson], Professor of Plant Pathology, *Department of Botany, University of Western Ontario, London, Ontario, Canada.* (Comparative morphology.)

Walker, Dr. Leva B[elle], Associate Professor of Botany, *University of Nebraska, Lincoln, Neb.* (Morphology.)

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Wehmeyer, Dr. Lewis E[dgar], Associate Professor, *Department of Botany, University of Michigan, 381 Orchard Hill Dr., Ann Arbor, Mich.* (Pyrenomycetes.)

Weidman, Dr. Fred[erick] D[eForest], *Medical Laboratories, University of Pennsylvania, 36th St. & Hamilton Walk, Philadelphia, Pa.* (Medical mycology and dermatology.)

Welch, Dr. Donald Stuart, Professor in Plant Pathology, *New York State College of Agriculture, Cornell University, Ithaca, N. Y.* (Taxonomy of Pyrenomycetes and Polyporaceae; forest pathology.)

Wellman, Dr. F[rederick] L[ovejoy], *Horticultural Field Station, Beltsville, Md.* (Physiology; morphology; variability; parasitism.)

Wernham, Dr. Clif[ford] C[harles], *Department of Botany, Pennsylvania State College, State College, Pa.* (Genetics and physiology.)

West, Dr. Erdman, Mycologist, *Florida Agricultural Experiment Station, Gainesville, Fla.* (Taxonomy of Florida fungi; timber decaying fungi; Myxomycetes; rusts; Sclerotium Rolfsii Sacc.)

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Whetzel, Prof. H[erbert] H[ice], Professor of Plant Pathology, Cornell University, *Plant Science Building, Ithaca, N. Y.* (Taxonomy; morphology; Sclerotineae.)

Whiffen, Dr. Alma J[oslyn], Research Assistant, *Department of Botany, University of North Carolina, Chapel Hill, N. C.* (Phycomycetes.)

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WOLF, DR. FRED[ERICK] T[AYLOR], Instructor in Botany, *Department of Biology, Vanderbilt University, Nashville, Tenn.* (Phycomycetes.)

WOOLLIAMS, G[EORGE] E[WART], Agricultural Scientist, Dominion of Canada, Department of Agriculture, *Dominion Laboratory of Plant Pathology, Summerland, B. C. Canada.* (Taxonomy; pathology.)

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YAW, MISS KATHERINE EMILY, Research Mycologist, *Parke-Davis & Co., 427 E. Grand Blvd., Detroit, Mich.*

YORK, DR. HARLAN H[ARVEY], Professor of Botany, *Department of Botany, University of Pennsylvania, Philadelphia, Pa.* (Forest Pathology.)

ZELLER, DR. SANFORD MYRON, Plant Pathologist, *Oregon Agricultural Experiment Station, Oregon State College, Corvallis, Ore.* (Parasitic fungi, Gasteromycetes, and other fleshy fungi.)

ZENTMYER, DR. GEORGE A., Assistant Plant Pathologist, *Connecticut Agricultural Experiment Station, New Haven, Conn.* (Chemotherapy for control of vascular diseases of trees, especially Dutch Elm disease.)

ZUNDEL, DR. GEORGE L[ORENZO INGRAM], Assistant Professor of Plant Pathology, Extension Div., *203 Botany Building, Pennsylvania State College, State College, Pa.* (Ustilaginales.)

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Watkins, G. M.

UTAH
Blood, H. L.
Richards, B. L.

VIRGINIA
Cook, H. T.
Cook, M. T.
Davidson, R. W.
Harper, R. A.
Hunt, N. R.
Lefebvre, C. L.
Luttrell, E. S.
Smart, R. F.

WASHINGTON
Aase, Hannah C.
Fischer, G. W.
Harrar, J. G.
Hatch, W. R.
Heald, F. De F.
Hotson, H. H.
Luretta, Sister Marion
Stuntz, D. E.

WEST VIRGINIA
Gilbert, F. A.
Leonian, L. H.
Orton, C. R.

WISCONSIN
Backus, M. P.
Bartsch, A. F.
Conant, G. H.
Gilbert, E. M.
Honey, E. E.
Keitt, G. W.
Lieneman, Catharine
McDonough, E. S.
Vinje, Mrs. J. M.
Watts, Mrs. H. M.

WYOMING
Solheim, W. G.

WALES
Cook, W. R. I.

CONSTITUTION AND BY-LAWS

CONSTITUTION

Art. 1. Name. The Society shall be known as the Mycological Society of America.

Art. 2. Membership.

(1) The Society shall consist of members and may include life members, patrons, honorary members, and corresponding members.

(2) Charter membership in the Society shall consist of the persons who, after the invitation of the Secretary, joined before or during the formal organization of the Society at the Atlantic City meetings in 1932.

Art. 3. Dues. The dues for regular members shall be five dollars a year. Any member may become a life member by paying one hundred dollars in one payment, or a patron by paying one thousand dollars, and upon election shall have all the privileges of members. Such funds obtained from life members and patrons shall constitute an endowment fund to be used as may be decided by the Council for the support of mycological publications or projects.

Annual dues of five dollars shall include subscription to the official organ of the Society, and shall be payable in advance on or before December 20. Bills for dues shall be sent to the members in October and it will be necessary to discontinue sending the journal to those whose dues have not been paid by December 20.

Art. 4. Membership and Election of Members.

(1) All persons interested in the study of the fungi shall be eligible to membership.

(2) Members may be elected at any regular meeting of the Society or in the interim between meetings may be elected by the Council. Application for membership must be endorsed by at least one member of the Society.

Art. 5. Officers. The officers of the Society shall consist of a President, Vice-President, and Secretary-Treasurer, whose duties shall be those usually performed by such officers. The President and Vice-President shall serve for one year and the Secretary-Treasurer for three years (or until their successors are elected). Any vacancies occurring in the interim between elections shall be filled by the Council.

The Council shall consist of the President, Vice-President, Secretary-Treasurer, and two Councilors. The Councilors shall be elected, one each year, to serve a term of two years. An individual may not hold two or more positions on the Council at one time.

The Council shall name a Historian to serve for an indeterminate period of years. It shall be the duty of the Historian to accumulate and preserve facts, papers, photographs, and other materials pertinent to a permanent historical record of the Society. The Historian shall not become a member of the Council by virtue of his office as Historian.

Art. 6. Editors and Committees. The editors of the official journal of the Society shall be elected by the Council. The President shall appoint all temporary committees that are to serve during his administration and shall fill all vacancies on standing committees that may occur during his term of office.

Art. 7. Election of Officers. The Secretary-Treasurer shall send to each member of the Society in October a ballot for the nomination of officers. If any nominations are lacking, the Council shall have power to make them. The three candidates for each office receiving the highest number of nominating votes shall be placed upon a final ballot to be sent to ecah member December 1. Should the nominating votes received by a candidate place him among the highest three for more than one office, his name shall appear on the final ballot for only the highest office. The offices rank in the order given in article 5. Votes shall be mailed to the Secretary-Treasurer and counted by the Council. A plurality vote shall elect.

Art. 8. Meetings. An annual meeting shall be held at such time and place each year as the Council may select (usually in connection with the A. A. A. S. meetings). An additional meeting for informal discussion and the carrying out of collecting forays shall be held in the summer or autumn at a time to be selected by the Council. Additional meetings, including special or local meetings for the presentation of papers or the carrying out of forays, may be arranged by the Council at its discretion.

Art. 9. Divisions. Branch organizations or units within the Society known as Divisions, may be established on a geographical basis provided formal application, setting forth the reasons for the establishment of the Division, is made to the parent Society and approved by it.

Art. 10. Journal. The Society shall adopt or establish a journal which shall serve the Society as its official organ primarily for the publication of mycological papers by its members, for the publication of abstracts of the papers delivered at the annual or other meetings, and for the publication of the report of the Auditing Committee or of other reports, announcements, and business of the Society.

Art. 11. Amendments. These articles may be amended by a majority vote of the members voting at any regular meeting of the Society, provided that suggested amendments have been brought to the attention of the Council of the Society in time to be sent to all of the members at least one month previous to the meeting.

BY-LAWS

1. Programs. Programs for annual or other meetings shall be arranged by the Council.

2. Papers. Members wishing to present papers at the annual meeting shall submit to the Secretary-Treasurer the substance and conclusions of the papers in a clear and concise abstract of not more than 200 words. These shall be due on or before November 15, and the Secretary-Treasurer shall be authorized to refuse any received after that date. These abstracts will be edited by the editorial committee of the official journal of the Society for subsequent publication in that organ. Members are urged not to submit titles or abstracts unless they expect to attend the meetings. Except by invitation no member shall offer more than two papers at any one meeting, papers of joint authorship being attributed to the author reading the paper.

3. Associates. Students and others not yet members of the Society may attend meetings and forays in the status of Associates, provided they are recommended to the Council by a member of the Society and pay a fee of one dollar. Such Associates, as they are not members, shall not have the privilege of voting and shall not receive the official journal of the Society, but shall enjoy the other privileges of the meetings and forays including the right to present one paper on the program.

4. Auditing. At each annual meeting the active President shall appoint an auditing committee to audit the accounts of the Society and of its official publication. An audited statement shall be published in the official organ of the Society.

5. Use of the Society's name. Unauthorized use of the name of the Mycological Society of America for advertising or other business ventures is prohibited. The circulation of any unauthorized literature shall be taken as prima facie evidence of the violation of the intent and purpose expressed in this by-law, and the member, after being properly notified, may be expelled from the Society by a majority vote of either the Society at its meetings, or by a majority vote of the Council.

6. These rules may be amended by a majority vote of the members voting at any regular meeting of the Society, provided that suggested amendments have been brought to the attention of the Council of the Society in time to be sent to all the members at least one month previous to the meeting.

CONTRACT WITH THE NEW YORK BOTANICAL GARDEN

The Mycological Society of America hereby adopts Mycologia as its official organ on the following terms:

1. Mycologia will continue to be published by the New York Botanical Garden, the editorial policies to be determined by an Editorial Board, consisting of a Managing Editor appointed by the New York Botanical Garden, and five Editors elected by the Mycological Society of America. The term of office of the five elected editors will be five years, except that at the start they will be designated to serve one to five years respectively. One editor will be elected annually, thereafter, to fill the place of each retiring editor.

The six members of the Editorial Board will elect an Editor-in-Chief from among their number. He will be eligible for repeated reëlection. Final decision of all questions on editorial policy will be made by him, except that the Managing Editor will have full authority in all matters pertaining to the finances of the journal.

2. All personal subscribers now receiving Mycologia may become members of the Mycological Society of America if they so desire. Institutional subscribers to Mycologia are not to be regarded as members of the Society.

3. All members of the Mycological Society of America in good standing will receive Mycologia. In return the Society will transmit to the New York Botanical Garden, through the Managing Editor, four dollars per year for each such member.

4. The New York Botanical Garden agrees to spend on the publication and distribution of Mycologia all funds received from subscriptions, as well as all funds transmitted by the Mycological Society of America. The Garden

further agrees to use for these purposes all sums received from the sale of those volumes of the journal which shall be published after this contract is put in force. Earlier volumes remain the property of the New York Botanical Garden. It is understood that the journal will be used by the Garden for exchange purposes as formerly. Should the contract be terminated, it is agreed by the Mycological Society of America that all excess stock of Mycologia then on hand will be regarded as the property of the New York Botanical Garden.

5. The New York Botanical Garden reserves the fourth cover page to be used without charge for the advertisement of its publications, including Mycologia. The other three cover pages will be used by the Mycological Society of America as it may see fit. All sums collected from paid advertising will be expended on the journal.

6. This contract may be altered at any time by mutual agreement of the New York Botanical Garden and the Mycological Society of America. It may be terminated at the end of any calendar year on six months written notice should it prove unsatisfactory to either party concerned.

7. The contract goes into effect at the beginning of the calendar year 1933.

PAST AND PRESENT OFFICERS OF THE SOCIETY

PRESIDENT

1932	Wm. H. Weston, Jr.
1933	C. L. Shear
1934	H. S. Jackson
1935	B. O. Dodge
1936	H. M. Fitzpatrick
1937	John Dearness
1938	L. O. Overholts
1939	H. H. Whetzel
1940	D. H. Linder
1941	E. A. Bessey

VICE-PRESIDENT

1933	G. W. Martin
1934	B. O. Dodge
1935	John Dearness
1936	A. H. R. Buller
1937	L. O. Overholts
1938	E. B. Mains
1939	D. H. Linder
1940	E. A. Bessey
1941	W. H. Snell

SECRETARY-TREASURER

1932–35	H. M. Fitzpatrick
1936–38	D. H. Linder
1939–41	J. N. Couch

COUNCILORS

1932	N. E. Stevens
1932–33	H. S. Jackson
1933–34	C. R. Orton
1934–35	L. O. Overholts
1935–36	C. L. Shear
1936–37	B. O. Dodge
1937–38	H. M. Fitzpatrick
1938–39	W. H. Weston
1939–40	L. O. Overholts
1940–41	H. H. Whetzel
1941–42	F. D. Kern

MEMBERSHIP COMMITTEE

F. J. Seaver, Chairman
S. M. Zeller
Erdman West
E. B. Mains

NOMENCLATURE COMMITTEE

D. P. Rogers, Chairman
H. M. Fitzpatrick
H. S. Jackson
E. B. Mains
F. J. Seaver
A. H. Smith
F. K. Sparrow

COMMITTEE ON PLANT PATHOLOGY

N. E. Stevens, Chairman
F. D. Kern
W. F. Hanna
G. W. Keitt
M. B. Linford
G. M. Reed
W. H. Weston

COMMITTEE ON MEDICAL MYCOLOGY

F. D. Weidman, Chairman
R. W. Benham
A. L. Carrion
N. F. Conant
C. W. Emmons
A. T. Henrici
J. G. Hopkins
A. Howell, Jr.

REPRESENTATIVES ON COUNCIL A. A. A. S. (1941)

J. G. Brown
C. W. Edgerton

REPRESENTATIVE TO NATIONAL RESEARCH COUNCIL

F. A. Wolf

REPRESENTATIVE TO EDITORIAL COMMITTEE AMERICAN JOURNAL OF BOTANY

G. F. Weber

FINANCIAL STATEMENT

January 1, 1939–December 21, 1939

Balance on hand			
Checking account			$ 697.70
Bonds			200.00
Collected in dues			2233.31
			$3131.01
Expenditures			
New York Botanical Garden for Mycologia		$1560.00	
Clerical help		14.50	
Postage		53.00	
Printing and Stationery		71.78	
Yearbook, 1939		76.40	
Secretary's travelling expenses to Richmond		42.75	
Checks returned (later collected)		25.00	
Collection charges		1.16	
		$1844.59	
Balance on hand			
Checking account	$ 586.42		
Savings account	500.00		
Bonds	200.00		
	$1286.42	1286.42	
		$3131.01	

(signed) J. N. COUCH, *Secretary-Treasurer*

Examined and found correct:

(signed) FRED J. SEAVER, *Chairman, Auditing Committee*

December 21, 1939 to January 1, 1941

Balance on hand	
Checking account	$ 586.42
Savings account	500.00
Bonds	200.00
Collected in dues	1804.30
	$3090.72

Expenditures

New York Botanical Garden for Mycologia		$1492.00
Returned checks (later collected)		20.00
Collection charges		2.68
Central bureau subsidy		25.00
Secretary's supplies (printing, etc.)		43.58
Mycological Foray expense		5.25
Biologists' Smoker		10.00
Secretary's travelling expenses, Chapel Hill, N. C. to Columbus, Ohio		57.24
State tax		.59
		$1656.34
Balance on hand		
Checking account	$ 734.38	
Savings account	500.00	
Bonds	200.00	
	$1434.38	1434.38
		$3090.72

(signed) J. N. COUCH, *Secretary-Treasurer*

Examined and found correct:

(signed) FRED J. SEAVER, *Chairman, Auditing Committee*

INDEX TO VOLUME XXXIII [1]

INDEX TO AUTHORS AND TITLES

[1] This index was prepared by Gussie Mildred Miller.

INDEX TO GENERA AND SPECIES

New names and the final members of new combinations are in **bold face type.** Mistakes in the spelling of scientific names encountered in text are corrected in the index.